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M-2 BAILEY BRIDGE (M2BB)  
PALLETIZATION TEST REPORT

June, 97

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By Anh V. Nguyen

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Approved for public release; distribution is unlimited.**12b. DISTRIBUTION CODE****13. ABSTRACT (Maximum 200 words)**

This report addresses the M-2 Bailey Bridge Palletization Test conducted at the U.S. Army Engineer School at Fort Leonard Wood, Missouri from 7 to 12 April 1997. The objectives of this test were to verify the feasibility of the M2BB Palletization Flatrack Load Configurations using M1/M1077 PLS Flatracks as shown below and to assure that these loads could be uploaded, downloaded, transloaded, and transported safely.

- |                                |                            |
|--------------------------------|----------------------------|
| (1) A: Erection Equipment Load | (2) B: Launching Load      |
| (3) C: Panel Load              | (4) D: Transom Load        |
| (5) E: Ramp/Others Load #1     | (6) F: Ramp/Others Load #2 |
| (7) G: Chess Load              |                            |

The test was conducted successfully and its results showed that the M2BB Palletization Flatrack Load Configurations can be used effectively and safely.

Loading and tiedown procedures for palletization were documented in detail during the test. These procedures will be incorporated into the M-2 Bailey Bridge manual.

**14. SUBJECT TERMS**

Military Bridging, Multi-Role Bridge Company (MRBC), M-2 Bailey Bridge (M2BB), Palletized Loading System (PLS), M1 Flatrack, M1077 Flatrack, M2BB Basic Set, M2BB Erection Equipment Set.

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## TABLE OF CONTENTS

<b>1. SUMMARY .....</b>	<b>1</b>
<b>2. INTRODUCTION .....</b>	<b>2</b>
<b>3. M-2 BAILEY BRIDGE PALLETIZATION TEST .....</b>	<b>5</b>
3.1. TEST OBJECTIVES .....	5
3.2. TEST CRITERIA .....	5
3.3. MATERIEL RESOURCES USED FOR THE TEST .....	6
3.3.1. Personnel .....	6
3.3.2. Materials .....	6
3.3.3. Test Location and Period .....	6
3.4. FLATRACK LOAD CONFIGURATIONS AND FLATRACK LOAD COMBINATIONS FOR TESTING .....	7
3.5. M1 AND M1077 PLS FLATRACKS .....	7
3.5.1. M1 ISO PLS Flatracks .....	7
3.5.2. M1077 PLS Flatracks .....	7
3.6. TEST PROCEDURES .....	8
3.6.1. Before Road Test .....	8
3.6.2. For Road Test .....	9
3.6.3. After Road Test .....	9
3.7. INSPECTION AND WEIGHING .....	10
3.7.1. Inspection .....	10
3.7.2. Weighing .....	10
3.8. SAFETY BRIEFINGS .....	10
<b>4. TEST RESULTS AND DISCUSSION .....</b>	<b>12</b>
4.1. USE OF MATERIAL HANDLING EQUIPMENT FOR LOADING AND UNLOADING M2BB COMPONENTS .....	12
4.2. FLATRACK LOAD CONFIGURATIONS C, D AND LOAD COMBINATION C&D .....	12
4.2.1. Flatrack Load Configuration C .....	12
4.2.2. Flatrack Load Configuration D .....	14
4.2.3. Road Test for Load Combination C&D .....	17
4.2.4. Repetitive Up/DownLoading and Transloading Test .....	17
4.2.5. Unloading M2BB Components of Flatrack Configuration C .....	19
4.2.6. Unloading M2BB Transoms of Flatrack Configuration D .....	20
4.3. FLATRACK LOAD CONFIGURATIONS F, G AND LOAD COMBINATION F&G .....	20
4.3.1. Flatrack Load Configuration F .....	20
4.3.2. Flatrack Load Configuration G .....	22
4.3.3. Road Test for Load Combination F&G .....	24
4.3.4. Repetitive Up/DownLoading and Transloading Test .....	24
4.3.5. Unloading M2BB Components of Flatrack Configuration G .....	25
4.4. FLATRACK LOAD CONFIGURATION E, F AND LOAD COMBINATION F&E .....	27
4.4.1. Flatrack Load Configuration E .....	27
4.4.2. Corrective Action on Flatrack Load Configuration F .....	30
4.4.3. Road Test for Load Combination F&E .....	32
4.4.4. Repetitive Up/DownLoading and Transloading Test .....	33
4.4.5. Unloading M2BB Components of Flatrack Configuration E .....	35
4.4.6. Unloading M2BB Components of Flatrack Configuration F .....	35
4.5. FLATRACK LOAD CONFIGURATIONS A, B AND LOAD COMBINATION B&A .....	35

4.5.1. Flatrack Load Configuration A .....	36
4.5.2. Flatrack Load Configuration B .....	38
4.5.3. Road Test for Load Combination B&A .....	42
4.5.4. Repetitive Up/DownLoading and Transloading Test .....	43
4.6. DISCUSSION .....	45
<b>5. CONCLUSIONS .....</b>	<b>47</b>
<b>6. RECOMMENDATIONS .....</b>	<b>48</b>
<b>7. DISTRIBUTION LIST .....</b>	<b>49</b>
<b>8. ATTACHMENT .....</b>	<b>51</b>
8.1. APPENDICES .....	51
8.2. ANNEX .....	64

## LIST OF FIGURES

FIGURE 1: M1 ISO PLS FLATRACK, TOP VIEW .....	8
FIGURE 2: M1077 PLS FLATRACK, TOP VIEW .....	8
FIGURE 3: FLATRACK LOAD CONFIGURATION C, RIGHT SIDE VIEW .....	13
FIGURE 4: FLATRACK LOAD CONFIGURATION C, LEFT SIDE VIEW .....	13
FIGURE 5: FLATRACK LOAD CONFIGURATION D, RIGHT SIDE VIEW .....	15
FIGURE 6: FLATRACK LOAD CONFIGURATION D, LEFT SIDE VIEW .....	15
FIGURE 7: FLATRACK LOAD CONFIGURATION D, END VIEW .....	16
FIGURE 8: LOAD COMBINATION C&D, RIGHT ANGLED-SIDE VIEW .....	18
FIGURE 9: LOAD COMBINATION C&D, LEFT ANGLED-SIDE VIEW .....	18
FIGURE 10: FLATRACK LOAD CONFIGURATIONS C AND D AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	19
FIGURE 11: FLATRACK LOAD CONFIGURATION D AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST	19
FIGURE 12: FLATRACK LOAD CONFIGURATION F, RIGHT SIDE VIEW .....	21
FIGURE 13: FLATRACK LOAD CONFIGURATION F, LEFT SIDE VIEW .....	21
FIGURE 14: FLATRACK LOAD CONFIGURATION G, RIGHT SIDE VIEW .....	23
FIGURE 15: FLATRACK LOAD CONFIGURATION G, LEFT SIDE VIEW .....	23
FIGURE 16: LOAD COMBINATION F&G, RIGHT ANGLED-SIDE VIEW .....	25
FIGURE 17: LOAD COMBINATION F&G, LEFT ANGLED-SIDE VIEW .....	25
FIGURE 18: RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATION G AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	26
FIGURE 19: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION G AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	26
FIGURE 20: FLATRACK LOAD CONFIGURATION E, RIGHT SIDE VIEW .....	27
FIGURE 21: FLATRACK LOAD CONFIGURATION E, LEFT SIDE VIEW .....	28
FIGURE 22: RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATION E, AFTER THE FIRST UP/DOWNLOADING AND TRANSLOADING TEST .....	30
FIGURE 23: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION E, AFTER THE FIRST UP/DOWNLOADING AND TRANSLOADING TEST .....	31
FIGURE 24: LOAD COMBINATION F&E, RIGHT ANGLED-SIDE VIEW .....	32
FIGURE 25: LOAD COMBINATION F&E, LEFT ANGLED-SIDE VIEW .....	32
FIGURE 26: RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS E AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	33
FIGURE 27: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS E AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	34
FIGURE 28: RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS F AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	34
FIGURE 29: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS F AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	35
FIGURE 30: FLATRACK LOAD CONFIGURATION A, RIGHT SIDE VIEW .....	37
FIGURE 31: FLATRACK LOAD CONFIGURATION A, LEFT SIDE VIEW .....	37
FIGURE 32: FLATRACK LOAD CONFIGURATION B, RIGHT SIDE VIEW .....	39
FIGURE 33: FLATRACK LOAD CONFIGURATION B, LEFT SIDE VIEW .....	40
FIGURE 34: LOAD COMBINATION B&A, RIGHT ANGLED SIDE VIEW .....	42
FIGURE 35: LOAD COMBINATION B&A, LEFT ANGLED SIDE VIEW .....	42
FIGURE 36: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION A AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	43
FIGURE 37: RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATION B AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....	44

<b>FIGURE 38: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION B AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST .....</b>	<b>44</b>
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## 1. SUMMARY

This report accounts the M-2 Bailey Bridge Palletization Test conducted at the US Army Engineer School at Fort Leonard Wood, Missouri from 7 to 12 April 1997. The results of this test showed that components of a M-2 Bailey Bridge Basic Set and a M-2 Bailey Bridge Erection Equipment Set can be transported safely using two M1077 Palletized Loading System flatracks and eighteen M1 International Organization for Standardization Palletized Loading System flatracks. These sets contain enough components to construct two 24.4 m (80-foot) double-truss single-story bridges with launching nose or one 39.0 m (130-foot) double-truss double-story bridge with launching nose. It is recommended that the component loading and tiedown procedures for the M2BB palletization described in this test report be incorporated in the M-2 Bailey Bridge manual.

## 2. INTRODUCTION

The existing M-2 Bailey Bridge (M2BB) setup requires 25 5-ton dump trucks and 10 4-ton bolster trailers to transport one M2BB Basic Set and one M2BB Erection Equipment Set. The panel bridge engineer company has two platoons, each capable of transporting one 24.4 m (80-foot) bridge, the most common bridge installed. Table 1 illustrates the existing M2BB truck loads in accordance with (IAW) FM 5-277.

**Table 1:** Existing M2BB Truck Loads IAW FM 5-277

LOAD	CARRIER	LOAD TYPE	MAIN COMPONENTS
#1	5-Ton Dump Truck	Part & Grillage	Erection Equipment
#2	5-Ton Dump Truck	Launching Nose	9 Panels, 8 Sway Braces, 12 Launching Nose Links
#3	5-Ton Dump Truck	Panel	9 Panels, 4 Ribands, 4 Sway Braces, Erection Tools
#4	4-Ton Bolster Trailer	Transom	7 Transoms
#5	5-Ton Dump Truck	Deck	52 Chess, 8 Button Stringers, 16 Plain Stringers
#6	5-Ton Dump Truck	Ramp	32 Chess, 4 Button ramps, 8 Plain Ramps, 4 Ribands, 2 15-Ton Jacks
#7	4-Ton Bolster Trailer	Footwalk	16 Footwalks, Rope for Handrail
#8	5-Ton Dump Truck	Spares	Spares of a Basic Set and an Erection Equipment Set

Total Army Analysis 2001 (TAA01) authorizes a total of 21 bridge companies. The US Army Engineer School (USAES) proposes that these remaining companies be configured into Multi-Role Bridge Companies (MRBCs) which would be capable of spanning both wet- and dry-gaps. To facilitate the move to the MRBC, a common transporter for both the Ribbon Bridge (RB) and the Heavy Dry Support Bridge (HDSB) is required. This transporter, the Common Bridge Transporter (CBT), is based on the Heavy Expanded Mobility Tactical Truck (HEMTT) chassis with Palletized Loading System (PLS) hardware attached.

A possible Bridge Company transition will be 10 Float Bridge Companies, 12 Medium Girder Bridge (MGB) Companies, and 1 M-2 Bailey Bridge (M2BB) Company forming into 12 MRBCs. To support the transition, the US Army Aviation-Troop Command (ATCOM) and USAES requested the Tank-Automotive Research Development and Engineering Center (TARDEC) Tactical Bridge Team (formerly the Support Bridge Team) examine the feasibility of placing



components of the M2BB Basic Set and the M2BB Erection Equipment Set on M1 International Organization for Standardization (ISO) PLS flatracks.

The result of the M2BB palletization study showed that the Bailey Bridge components of a Basic Set and an Erection Equipment Set can be configured on eighteen M1 ISO PLS flatracks and two M1077 PLS flatracks, in seven load configurations as illustrated in Table 2. M1077 PLS flatracks are used only for the M2BB transoms since the M2BB transoms are longer than the M1 ISO PLS flatrack's deck length. To verify these configurations before adopting them for use, the Tactical Bridge Team developed the M2BB Palletization Test Plan as described in Annex 1, and then conducted the test at the USAES at Fort Leonard Wood, Missouri from 7 to 12 April 1997.

**Table 2: M2BB Palletization Load Configurations**

LOAD CONFIGURATION	FLATRACK TYPE	DESCRIPTION	COMPONENTS
A	M1	Erection Equipment Load	18 Button Stringers 32 Rakers 162 Soft-wood Lumber, Dimension 3 Erection Equipment Boxes <sup>a</sup>
B	M1	Launching Load	9 Panels 8 Sway Braces 97 Soft-wood Lumber, Timber 4 Miscellaneous Boxes <sup>b</sup>
C	M1	Panel Load	9 Panels 12 Plain Stringers 8 Sway Braces
D	M1077	Transom Load	28 Transoms
E	M1	Ramp/Others Load #1	9 Panels 8 Button Ramps 8 Ramp Pedestals 25 Bracing Frames 4 Base Plates 6 Female & 6 Male End Posts 40 Footwalk Bearers 40 Footwalk Posts 8 Bearing Shoes
F	M1	Ramp/Others Load #2	9 Panels 8 Plain Ramps 12 Ribands
G	M1	Chess Load	185 Chess 18 Footwalks

<sup>a</sup>Erection Equipment Boxes include 7 Carrying Bars, 4 Double Blocks, 2 Triple Blocks, 2 Snatch Blocks, 2 Pin Extractors, 6 Double-Face Hammers, 1 Carpenter Hammer, 5 Socket Wrench Handles, 6 Holdfast w/ 9 pickets, 3 Chord Jacks, 5 15-ton Rack Bar Jacks, 3 Panel Levers, 12 Launching Nose Links, 5 Rubber Mallets, 3 50-lb boxes Steel Nail, 10 Common Nail Boxes, 6 Plain Rollers, 6 Rocking Rollers, 3 Guide Roller Assemblies, 2 Transom Rollers, 1 3" Circular Rope, 1 2 1/4" Circular Rope, 2 2" Circular Ropes, 2 Anchor-Type Shackles, 4 Jack Shoes, 2 Sling & Wire Rope Assemblies, 5 1 1/8", 12 PT Sockets, 5 1 7/8", 12 PT Sockets, 9 Steel Anchor Stakes, 6 Rocking Roller Templates, 6 Plain Roller Templates, 10 Carrying Tongs, 16 Wood Wedges, 2 Wire Rope Assemblies, 2 3/4", 12 PT Box Wrenches, 5 1 1/8" Open End Wrenches, 5 1 1/2" Open End Wrenches, 5 1 7/8" Open End Wrenches, 10 1 1/8" Single Socket Wrenches.

<sup>b</sup>Miscellaneous Boxes include 250 Bracing Bolts, 100 Chords Bolts, 150 Ribald Bolts, 150 Transom Clamps, 20 Steel Pickets, 150 Panel Pins, 15 Short Panel Pins, 25 Sway Braces Pins, 13 Tie Plates, 500 Pin Retainers, 1 Roll of Ropes, and 10 Tools and Parts Bags, 12 Hex Nuts with Caps, and 12 End Post Bolts.

### **3. M-2 BAILEY BRIDGE PALLETIZATION TEST**

#### **3.1. Test Objectives**

The objectives of the test were to verify the feasibility of the M2BB Palletization Flatrack Load Configurations using M1/M1077 PLS Flatracks and to assure that these loads can be uploaded, downloaded, transloaded, and transported safely. Specific objectives were:

- (1) Can M2BB components fit on the flatrack as modeled?
- (2) Can M2BB components be tied down using twenty two (22) 4,536-kg (10,000-lb) nylon straps equipped with the flatrack?
- (3) Are M2BB components stable in the modeled configuration?
- (4) Can loaded flatracks be uploaded, downloaded, transloaded, and transported safely? (It is unsafe if components excessively shift or move during uploading, downloading, transloading or transporting.)
- (5) Is it difficult to load and unload components from the flatrack without the aid of Materials Handling Equipment?

#### **3.2. Test Criteria**

The following criteria were used for the test:

- (1) The M2BB components of Flatrack Load Configurations A, B, C, E, F, and G will fit onto the usable deck area of the PLS ISO Flatrack M1 which is 2.30 x 5.64 m (90.5 x 222 in).
- (2) The load height of each M1 Flatrack Load Configuration will not exceed 2.07 m (81.5 in) from the flatrack base.
- (3) M2BB components will be secured by utilizing the existing 4,536-kg (10,000-lb) rated web straps and tiedown rings of the PLS flatrack. Other tiedown methods will not be allowed.
- (4) M2BB load configurations will not shift during uploading, downloading, transloading, and transporting.
- (5) M2BB components will not shift on the deck area of the PLS flatrack during uploading, downloading, transloading,

and transporting.

- (6) M2BB load configurations will not shift during emergency braking or during hard turning maneuvers.
- (7) M2BB components will not shift on the deck area of the PLS flatrack during emergency braking or during hard turning maneuvers.

### **3.3. Materiel Resources Used for the Test**

#### **3.3.1. Personnel**

Personnel were provided as requested in the test plan. Sierra Army Depot provided 2 Quality Assurance (QA) personnel and USAES provided a loading/unloading party which included 2 Non-Commissioned Officers (NCO) and 14 enlisted men (EM). Appendix 1 illustrates a list of personnel participating in the M2BB palletization test.

#### **3.3.2. Materials**

- (1) USAES provided all the M2BB components required for the test.
- (2) Test equipment included the following:
  - One M1075 PLS transporter.
  - One M1076 PLS trailer.
  - Nine M1 ISO PLS flatracks.
  - One M1077 PLS flatrack.
  - Two 10K Rough Terrain Forklift trucks.

#### **3.3.3. Test Location and Period**

The M2BB Palletization Test was conducted at the USAES at Fort Leonard Wood, Missouri as scheduled from 7 to 12 April 1997. The selected route for the road test included 11.58 km (7.2 miles) of hard surface road and 8.53 km (5.3 miles) of unimproved road. The test route was winding, and the unimproved portion was very rough and had a few sharp turns. The route was appropriate for the M2BB palletization road test. The speed used for the road test was 72.41 km/h (45 mph) on the hard surface road and 56.32 km/h (35 mph) on the unimproved road.

### 3.4. Flatrack Load Configurations and Flatrack Load Combinations for Testing

Each flatrack load configuration illustrated in Table 1 was tested for component loading, component unloading, uploading and downloading (a loaded flatrack from ground to a PLS truck and vice versa), and transloading (a loaded flatrack from a truck to a trailer and vice versa). Combinations of two load configurations were tested for transport (road test). Table 3 shows flatrack load combinations which were used in the road test.

**Table 3:** Flatrack Load Combination for Testing

COMBINATION	FLATRACK (PLS TRUCK)	FLATRACK (PLS TRAILER)	TYPE OF FLATRACK
C&D	C	D	M1/M1077
F&G	F	G	M1/M1
F&E	F	E	M1/M1
B&A	B	A	M1/M1

### 3.5. M1 and M1077 PLS Flatracks

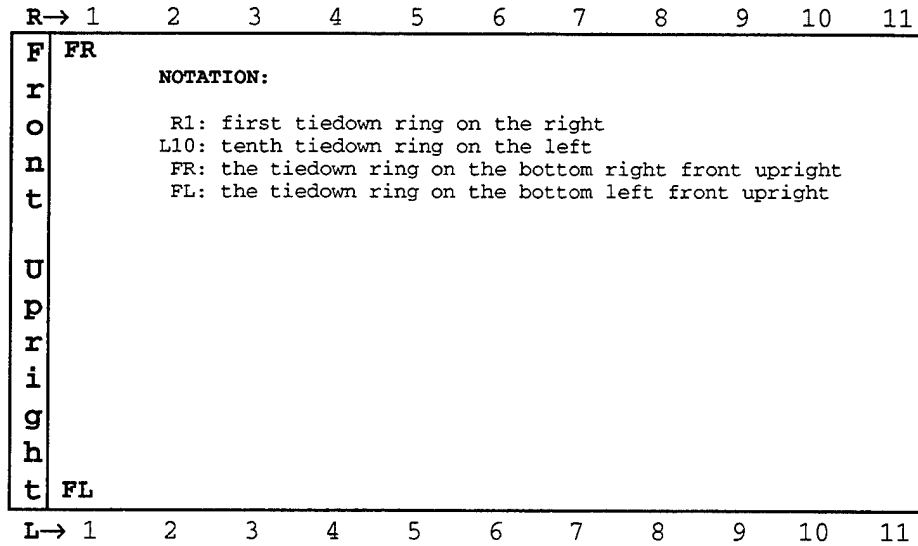
#### 3.5.1. M1 ISO PLS Flatracks

The M1 ISO flatrack has a useable area of 2.30 x 5.64 m (90.5 x 222 in), and its tare weight is 3,311 kg (7,300 lb). The height of the upright is 2.07 m (81.5 in) from the flatrack base. The flatrack is equipped with 22 4,536-kg (10,000-lb) rated nylon straps. These strap are 6.10 m (20 feet) long. It is noted that the allowable payload of a CBT with a M1 flatrack is 7,120 kg (15,700 lb). Figure 1 illustrates the top view of this flatrack with some of the notations used in this report.

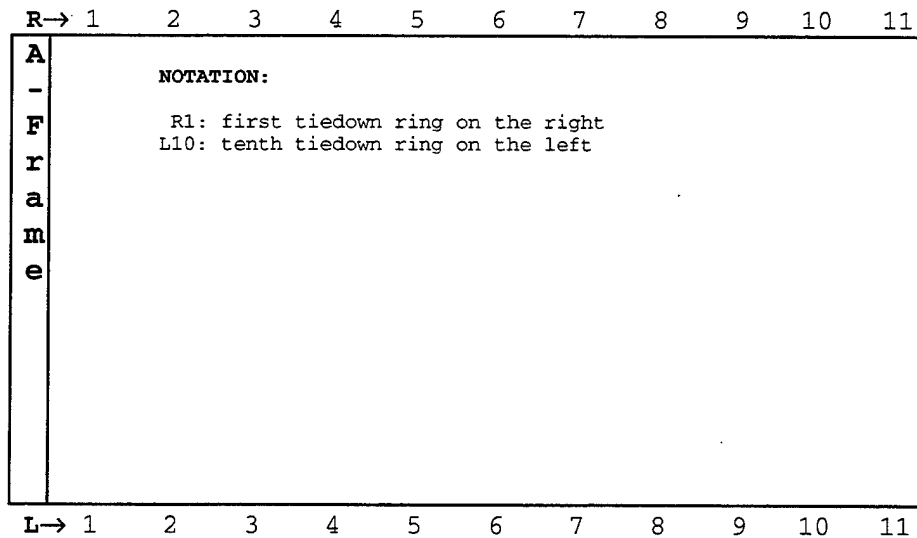
#### 3.5.2. M1077 PLS Flatracks

The M1077 flatrack has a useable area of 2.31 x 5.79 m (91 x 228 in), and its tare weight is 3,270 kg (3,250 lb). The flatrack is equipped with 22 4,536-kg (10,000-lb) rated nylon straps. These strap are 6.10 m (20 feet) long. It is noted that the allowable payload of a CBT with a M1077 flatrack is 8,960 kg (19,750 lb). Figure 2 illustrates the top view of this flatrack with some of the notations used in this report.

**FIGURE 1: M1 ISO PLS FLATRACK, TOP VIEW**



**FIGURE 2: M1077 PLS FLATRACK, TOP VIEW**



### 3.6. Test Procedures

The M2BB Palletization Test was performed using test procedures stated in the test plan. Following is the brief description of these procedures.

#### 3.6.1. Before Road Test

(1) Load and tiedown M2BB components on a flatrack for a specific load configuration. Document if components do not fit as modeled. Measure the load height from the flatrack base. Document component loading and tiedown procedures. Take two side (left and right) view photographs of the flatrack load. (In the case of Configuration D, take an additional photograph for end view.)

(2) Upload & download a loaded flatrack five (5) times. Inspect load for shifting. Transload a loaded flatrack five (5) times. Inspect load for shifting. Take photographs if load shifting occurs.

### 3.6.2. For Road Test

(1) Hook up a combination, one flatrack load configuration on a PLS trailer and the other configuration on a PLS truck, and take two angled-side (left and right) view photographs before performing the road test.

(2) Roadmarch on the selected hard surface road with a maximum speed of 72.41 km/h (45 mph). Stop and inspect load for shifting.

(3) Road march on the selected unimproved road with a maximum speed of 56.32 km/h (35 mph). Stop and inspect load for shifting.

(4) Conduct emergency braking test as follows:

- Apply one hard stop on the hard surface road at 72.41 km/h (45 mph), 2 times. Stop and inspect load for shifting.
- Apply one hard stop on the unimproved road at 56.32 km/h (35 mph), 1 time. Stop and inspect load for shifting.

(5) Conduct turning test for a turning radius of 36.5 m (119.76 ft) wall-to-wall. Stop and inspect load for shifting. The selected road test route had sharp turns and small loops which were very appropriate for this test.

### 3.6.3. After Road Test

(1) Disconnect PLS trailer flatrack and download PLS truck flatrack.

(2) Transload PLS trailer flatrack five (5) times. Inspect load for shifting. Take photographs if load shifting occurs. Download and upload PLS trailer flatrack five (5) times. Inspect load for shifting. Take photographs if load shifting occurs.

(3) Transload PLS truck flatrack five (5) times. Inspect load for shifting. Take photographs if load shifting occurs. Download and upload PLS truck flatrack five (5) times. Inspect load for shifting. Take photographs if load shifting occurs.

(4) Remove M2BB components from the PLS flatrack. Document all loose parts and parts that fall when removing tiedowns. Take photographs of fallen components, if any.

### **3.7. Inspection and Weighing**

#### **3.7.1. Inspection**

(1) The responsible USAES personnel inspected the Bailey Bridge components before the test. These components were in good condition and of sufficient quantity for the test. The M2BB erection components at USAES did not include 3 x 6 x 54 and 6 x 6 x 54 soft-wood lumber. For testing, these types of lumber were substituted by railroad lumber as discussed in Paragraph 4.

(2) Preventive Maintenance Checks and Services were conducted daily during the test by the PLS truck operators for the PLS transporter and PLS trailer; and by the forklift operators for the forklift trucks. All the PLS flatracks were in good condition before the test.

#### **3.7.2. Weighing**

The empty M1 ISO PLS flatrack and each flatrack load were weighed.

### **3.8. Safety Briefings**

A safety brief was conducted every morning during the palletization test. The following information was covered during daily safety briefs:

- Gloves to be worn while handling bridge components.
- Ensure that hands, fingers and feet stay clear while bridge



components are being moved.

- Lift bridge components with legs as a group. Do Not lift with your backs.
- One person on the right back side of the bridge component gives lifting commands.
- Location of first aid kit provided.
- Procedures for medical assistance if needed.
- Pay attention to all instructions and moving equipment.
- Anyone who needs to set a heavy component down would say in a loud tone "CHECK" which would mean that everyone would immediately set the component down.

#### **4. TEST RESULTS AND DISCUSSION**

##### **4.1. Use of Material Handling Equipment for Loading and Unloading M2BB Components**

The use of material handling equipment was not allowed to load M2BB components on a flatrack during the test. However, to save time and energy of the soldiers for the MGB Palletization Test which would be conducted after the completion of the M2BB Palletization Test, forklift trucks were used to remove heavy components from a flatrack.

##### **4.2. Flatrack Load Configurations C, D and Load Combination C&D**

###### **4.2.1. Flatrack Load Configuration C**

###### **4.2.1.1. Loading M2BB Components for Configuration C**

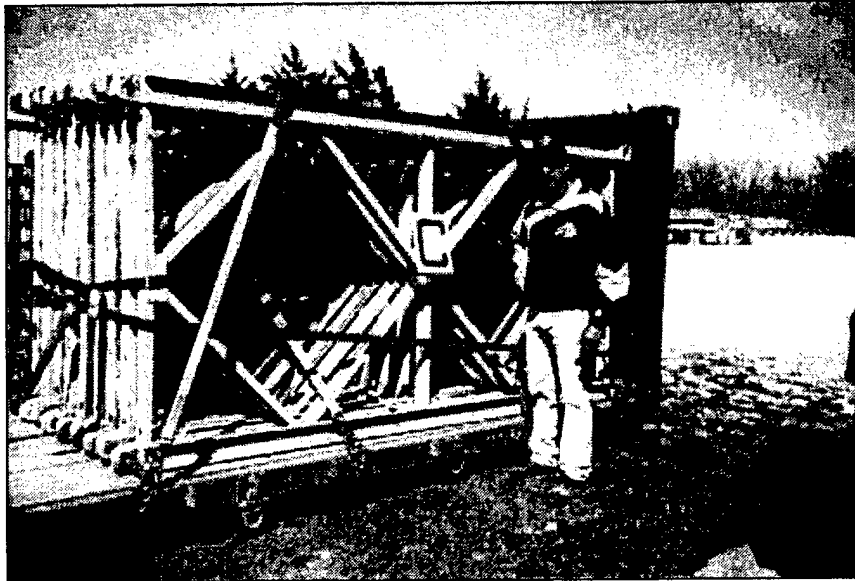
The loading party loaded 9 panels, 12 plain stringers, and 8 sway braces on a M1 flatrack and tied them down using 4,536-kg (10,000-lb) rated nylon straps equipped with the flatrack. These components fitted on the M1 flatrack as modeled. The load height from the flatrack base was measured as 1.85 m (73 in). This height is less than the height of the upright. The loaded flatrack weighed 7,344 kg (16,190 lb). The resultant payload of Configuration C is 4,032 kg (8,890 lb). This payload is much less than the allowable payload of 7,120 kg (15,700 lb). Two photographs of this flatrack configuration were taken for the left side and right side views with the tiedown straps. These photographs, shown in Figures 3 and 4, prove that the components of Configuration C fit within the envelope of the M1 flatrack.

###### **4.2.1.2. Description of Component Loading and Tiedown Procedures**

(1) Load 9 panels upright, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is 5 in from the flatrack edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible. Insert a metal bar through the bottom lug holes at the rear end to keep one panel from sliding away from the other.

(2) Load 12 plain stringers lengthwise one on top the other next to the panels.

**FIGURE 3:** FLATRACK LOAD CONFIGURATION C, RIGHT SIDE VIEW



**FIGURE 4:** FLATRACK LOAD CONFIGURATION C, LEFT SIDE VIEW



- (3) Load 8 sway braces on top of the plain stringers.
- (4) Secure these components on the flatrack as follows:
  - One strap from R3 through the panels, over the sway braces and stringers to L3.
  - One strap from R5 through the panels, over the sway

braces and stringers to L5.

- One strap from R1 over the panels, sway braces, and stringers to L7.
- One strap from R7 over the panels, sway braces, and stringers to L1.
- Join two straps to make a 40-foot strap and run it from FR, midway up the rear vertical member of the outer panel parallel with the deck surface, go around the rear end of the stringers to FL. This tiedown keeps the load from shifting backward. It is noted that the ratchet end of this strap is at the middle end of the strap.

#### 4.2.1.3. Up/Downloading and Transloading Test

- (1) The components of Configuration C did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration C did not shift when the flatrack was transloaded from a PLS truck to a PLS trailer and vice versa 5 times.

#### 4.2.2. Flatrack Load Configuration D

##### 4.2.2.1. Loading M2BB Components for Configuration D

The loading party loaded 28 transoms onto a M1077 flatrack and tied them down using 4,536-kg (10,000-lb) rated nylon straps equipped with the flatrack. These components fitted on the M1077 flatrack as modeled. The load height from the flatrack base was measured as 0.99 m (39.0 in). The loaded flatrack weighed 10,124 kg (22,320 lb). The resultant payload of Configuration D is 8,650 kg (19,070 lb). This payload is less than the allowable payload of 8,960 kg (19,750 lb). There was an overhang of 0.37 m (14.5 in) off the rear of the M1077 flatrack because of the lumber used between the A-frame and the transom ends. Three photographs were taken from the left side, right side, and end of the flatrack load after tiedown. These photographs are shown in Figures 5, 6 and 7.

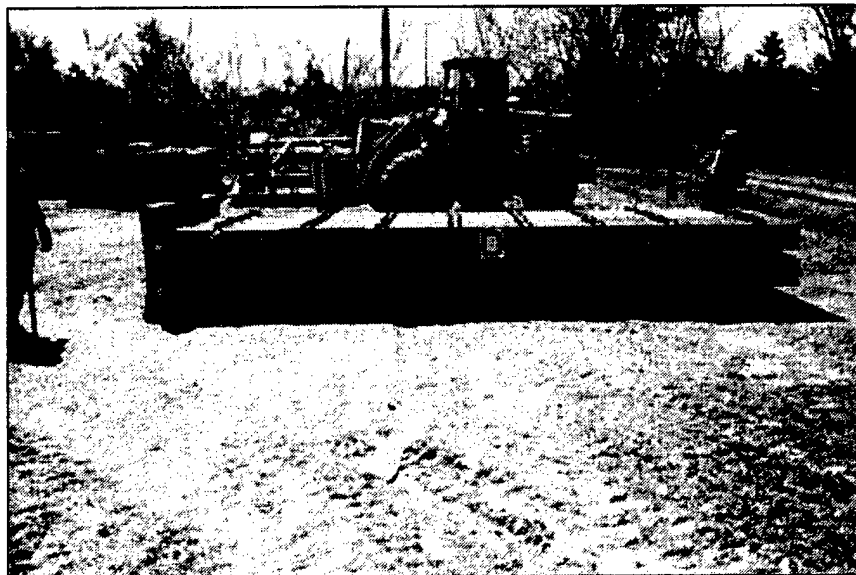
##### 4.2.2.2. Description of Loading and Tiedown Procedures

- (1) Load 14 transoms on the deck area of a M1077 PLS flatrack lengthwise and side by side to form a layer. The outer transom of this transom layer is 14 inches from the edge of the flatrack.

**FIGURE 5:** FLATRACK LOAD CONFIGURATION D, RIGHT SIDE VIEW



**FIGURE 6:** FLATRACK LOAD CONFIGURATION D, LEFT SIDE VIEW



Use 2 pieces of 3 x 6 x 54 lumber between the A-frame and the front end of the transom layer as a barrier for aligning the transoms against the A-frame.

(2) Secure this layer on the flatrack as follows:

- One strap from R9 through the 6<sup>th</sup> (end) web holes of the transoms to L9.

**FIGURE 7:** FLATRACK LOAD CONFIGURATION D, END VIEW



- One strap from R8 through the 4<sup>th</sup> web holes of the transoms to L8.
- One strap from R2 through the 3<sup>rd</sup> web holes of the transoms to L2.
- One strap from R3 through the first web holes of the transoms to L3.

(3) Put 4 pieces of 3 x 6 x 54 lumber on top of the other two pieces at the A-frame forming three rows of lumber. These lumber will serve as a barrier for aligning the second layer of transoms against the A-frame. Put 8 pieces of 3 x 6 x 54 lumber on top of the first transom layer crosswise to make 4 overlapped crossing rows. The distance between each row and between the first row at the A-frame is approximately 40 inches. Then, load 14 transoms to form a second transom layer exactly the same as the first one.

(4) Secure the second layer transoms as follows:

- One strap from R9 through the 6<sup>th</sup> (end) web holes of the second layer transoms to L9.
- One strap from R8 through the 4<sup>th</sup> web holes of the second layer transoms to L8.
- One strap from R2 through the 3<sup>rd</sup> web holes of the second layer transoms to L2.

- One strap from R3 through the first web holes of the second layer transoms to L3.

(5) Secure both transom layers on the flatrack as follows:

- One strap runs from R1 over the second transom layer to L1, and another one from R11 over the second transom layer to L11. These two straps are placed behind the transom lugs.
- One strap runs from R6 over the second transom layer to L6.

#### 4.2.2.3. Up/Downloading and Transloading Test

- (1) The components of Configuration D did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration D did not shift when the flatrack was transloaded from a PLS truck to a PLS trailer and vice versa 5 times.

#### 4.2.3. Road Test for Load Combination C&D

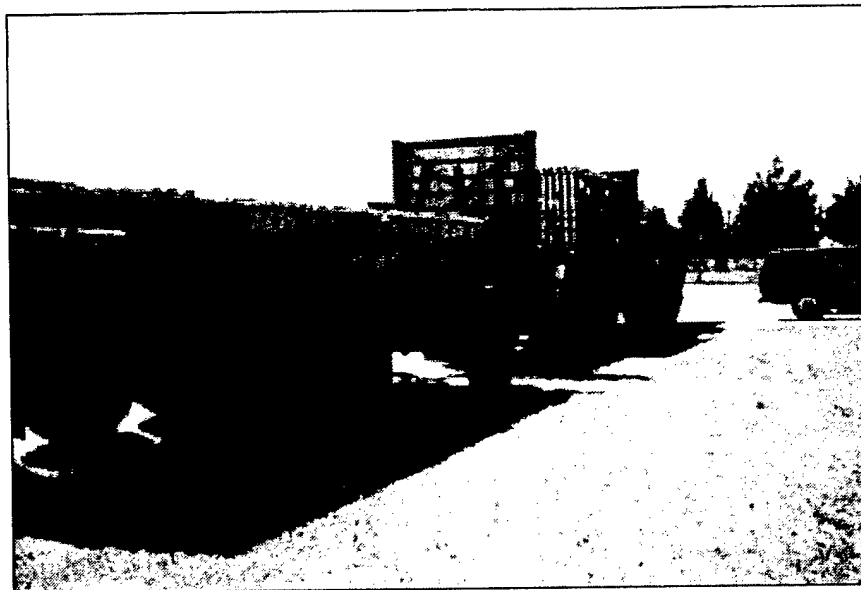
The combination of Configuration C (on the PLS truck) and Configuration D (on the PLS trailer) was hooked up. Two angled-side (left and right) view photographs, taken before the road test, are displayed in Figures 8 and 9.

The road test for this combination was performed as explained in Paragraph 3.6.2 from (2) to (5). The M2BB components of Flatrack Configurations C and D did not obviously shift during the road test.

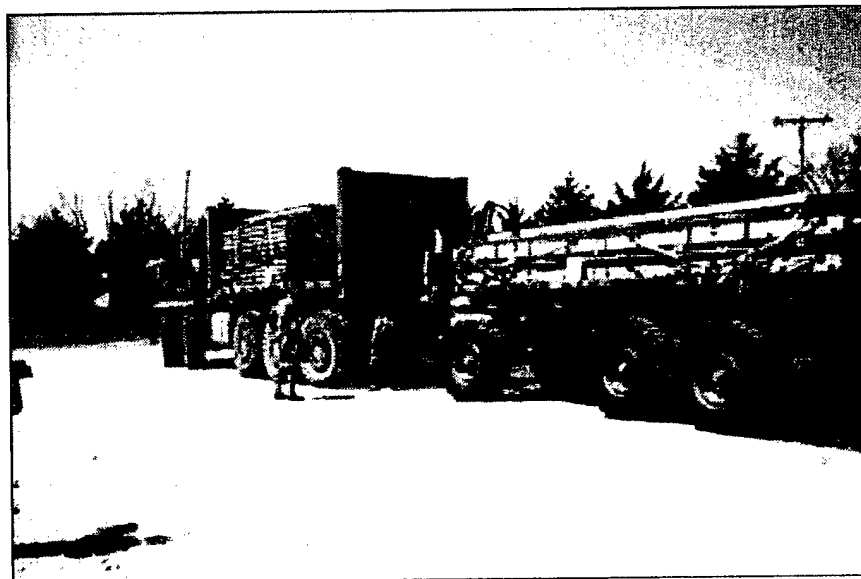
#### 4.2.4. Repetitive Up/DownLoading and Transloading Test

- (1) There were no shifting of components on Flatrack Configuration C from the up/downloading and transloading 5 times.
- (2) Some transoms of both layers at the middle of Flatrack Configuration D shifted backward slightly during the up/downloading and transloading. The maximum shift was 0.6 m (2.5 in), and the overhang at this spot became 0.43 m (17 in).

**FIGURE 8:** LOAD COMBINATION C&D, RIGHT ANGLED-SIDE VIEW



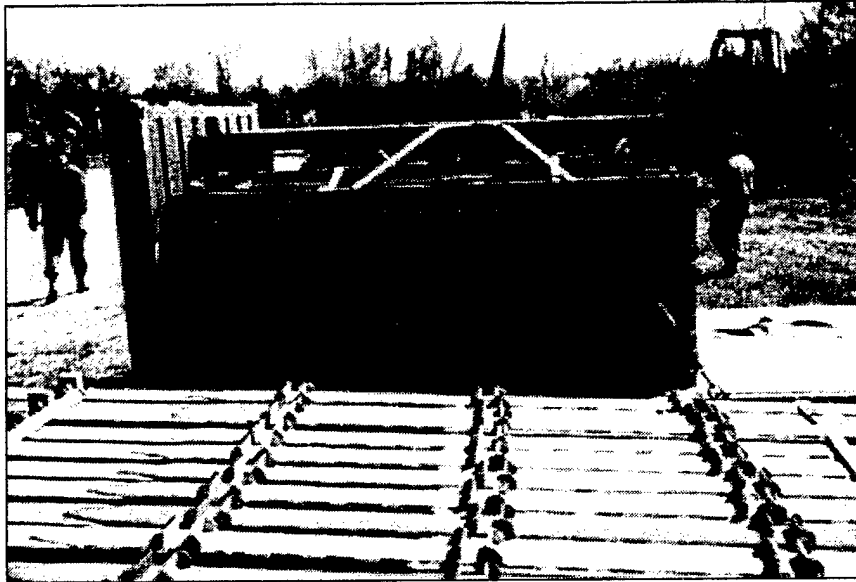
**FIGURE 9:** LOAD COMBINATION C&D, LEFT ANGLED-SIDE VIEW



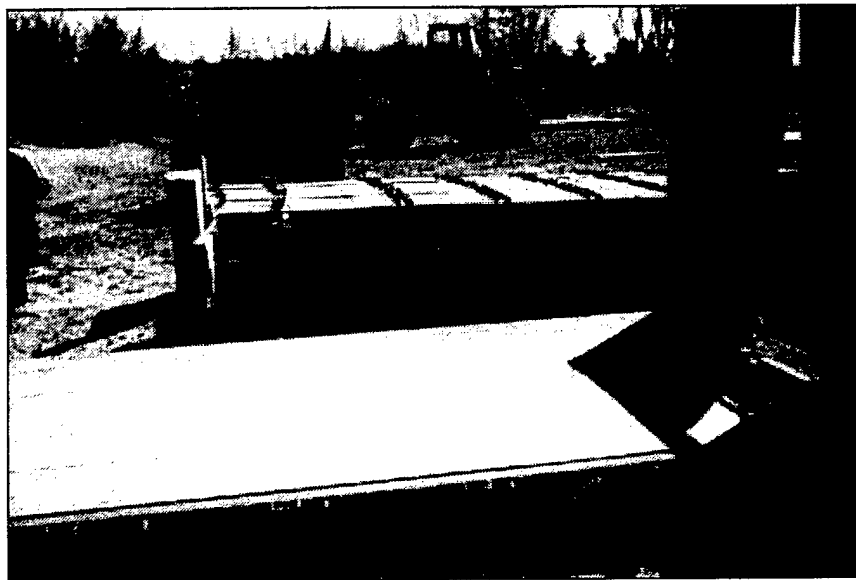
- (3) Two photographs, which were taken after the repetitive up/downloading and transloading test, are displayed in Figures 10 and 11. The shift that occurred on Flatrack Configuration D was insignificant.



**FIGURE 10:** FLATRACK LOAD CONFIGURATIONS C AND D AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



**FIGURE 11:** FLATRACK LOAD CONFIGURATION D AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



#### 4.2.5. Unloading M2BB Components of Flatrack Configuration C

The components of Flatrack Configuration C were untied and removed in the reverse order of the component loading and tiedown described in Paragraph 4.2.1.2. There were no loose components,

and no components fell when removing the tiedown. The M1 flatrack did not have any damage.

#### 4.2.6. Unloading M2BB Transoms of Flatrack Configuration D

The M2BB transoms was untied and removed in the reverse order of the component loading and tiedown described in Paragraph 4.2.2.2. There was no damage to the M1077 flatrack.

### 4.3. Flatrack Load Configurations F, G and Load Combination F&G

#### 4.3.1. Flatrack Load Configuration F

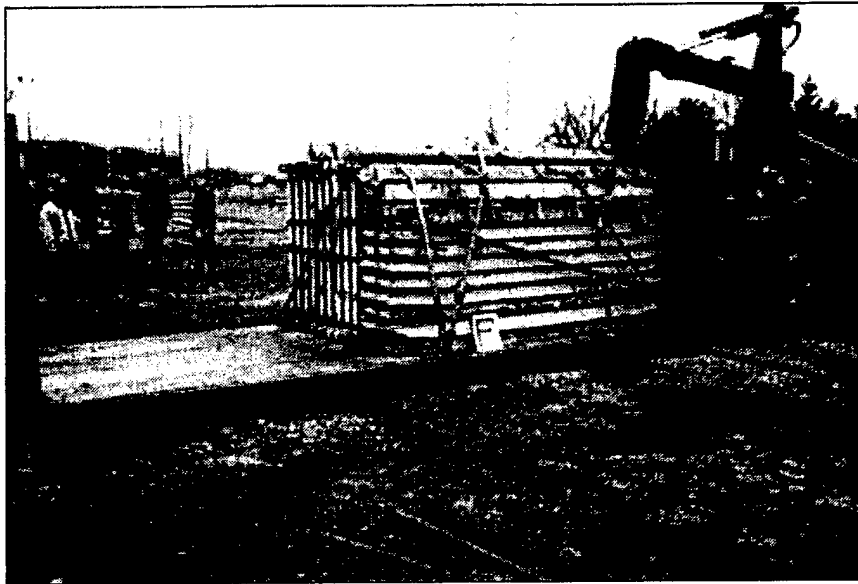
##### 4.3.1.1. Loading M2BB Components for Configuration F

The loading party loaded 9 panels, 8 plain ramps, and 12 ribands on a M1 flatrack and tied them down using 4,536-kg (10,000-lb) rated nylon straps equipped with the flatrack. These components fitted on the M1 flatrack as modeled. However, the ribands were stacked at different locations as shown on the model because there were no boxes used for the ribands. The load height from the flatrack base was measured as 2.01 m (79 in). This height is less than the height of the upright. The flatrack with components of Configuration F weighed 8,319 kg (18,340 lb). The resultant payload of Configuration F is 5,008 kg (11,040). This payload is much less than the allowable payload of 7,120 kg (15,700 lb). Two photographs were taken from the left side and right side of the flatrack load after tiedown. These photographs, illustrated in Figures 12 and 13, prove that the components of Configuration F fit within the envelope of the M1 flatrack.

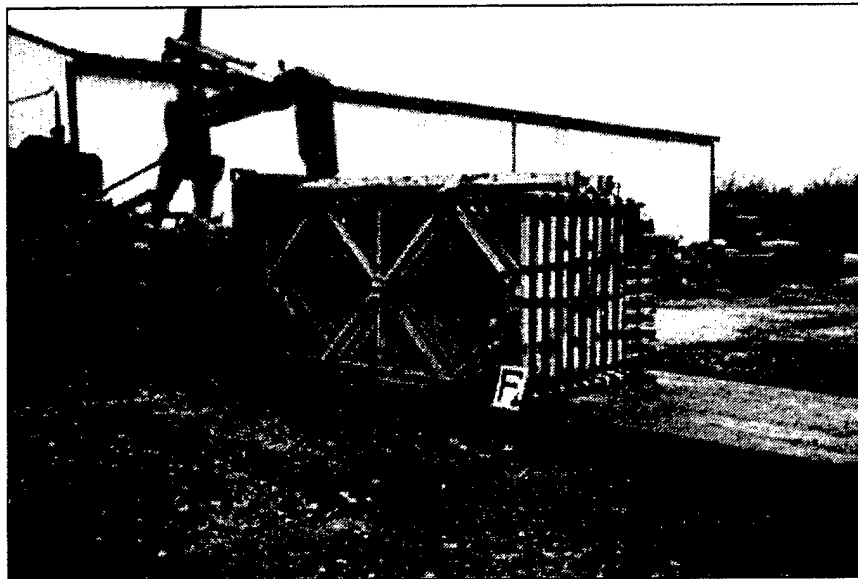
##### 4.3.1.2. Description of Component Loading and Tiedown Procedures

(1) Load 9 panels upright on the left side of the flatrack, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is 5 in from the flatrack edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible. Insert 2 pickets through the bottom lug holes of both sides and one picket through the top lug holes on the right at the rear end to keep one panel from sliding away from the other. Run a strap from the D-handle of the top picket down to the D-handle of the left bottom picket, over to the D-handle of the right bottom picket, to R6.

**FIGURE 12:** FLATRACK LOAD CONFIGURATION F, RIGHT SIDE VIEW



**FIGURE 13:** FLATRACK LOAD CONFIGURATION F, LEFT SIDE VIEW



(2) Stack 8 plain ramps lengthwise one on top the other next to the panels.

(3) Stack 8 ribands on top of the plain ramps with one strap wrapped around the middle of the bundle.

(4) Bolt the remaining ribands with bracing bolts to make 2 pairs. Stack these two riband pairs on top of the panels

lengthwise and at the middle of the panels. Put 2 pickets behind the riband pairs to keep them from moving backward.

(6) Secure these components on the flatrack as follows:

- One strap from R1 over the complete load to L6.
- One strap from R6 over the complete load to L1.
- One strap from R6 over the ramps and ribands, through the panels to L6.
- Join two straps to make a 40-foot strap and run it from FR to the bottom right end corner of the riband on top of the ramps, around the end of the ribands and panels in parallel with the deck surface to FL. This tiedown keeps the load from shifting backward. It is noted that the ratchet end of this strap is at the middle end of strap.

#### 4.3.1.3. Up/Downloading and Transloading Test

- (1) The components of Configuration F did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration F did not shift when the flatrack was transloaded 5 times.

#### 4.3.2. Flatrack Load Configuration G

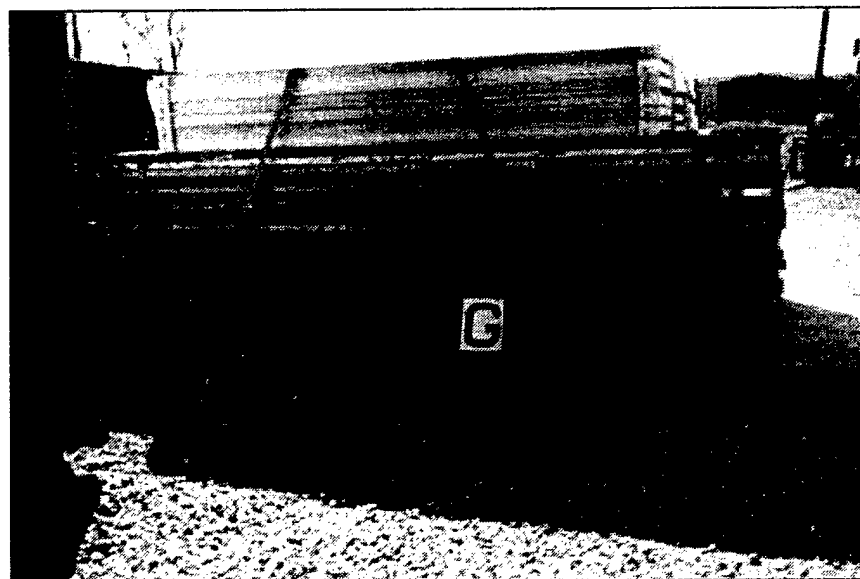
##### 4.3.2.1. Loading M2BB Components for Configuration G

The loading party loaded 185 chess and 18 footwalks on a M1 flatrack and tied them down using 4,536-kg (10,000-lb) rated nylon straps equipped with the flatrack. These components fitted on the M1 flatrack as modeled. The load height from the flatrack base was measured as 1.93 m (76.0 in). This height is less than the height of the upright. The loaded flatrack weighed 9,213 kg (20,310 lb). The resultant payload of Configuration G is 5,901 kg (13,010 lb). This payload is less than the allowable payload of 7,120 kg (15,700 lb). Two photographs, taken from the left side and right side of the flatrack load after tiedown, are illustrated in Figures 14, and 5.

**FIGURE 14:** FLATRACK LOAD CONFIGURATION G, RIGHT SIDE VIEW



**FIGURE 15:** FLATRACK LOAD CONFIGURATION G, LEFT SIDE VIEW



#### 4.3.2.2. Description of Loading and Tiedown Procedures

(1) Stack 18 layers of chess on a M1 flatrack with one end of these layers about 1 inch from the A-frame of this flatrack. Each layer contains 10 chess. The outer chess of the bottom layer is about 1.5 inches from the flatrack edge of each side. Then lay the remaining 5 chess on top of the top layer spaced apart approximately 0.22 m (8.5.in). The distance from one outer

chess of these 5 chess to the top layer edge of each side is also 0.22 m (8.5 in.). The ends of these chess are even with the other chess ends. Secure the chess load by 3 straps from R1 to L1, from R2 to L2, and from R8 to L8.

(2) Stack three bundles of footwalks on top of the chess load in the middle of the top area. Each bundle contains 6 footwalks. Secure the chess load and the footwalk load by two straps crisscrossing from R3 to L7 and from R7 to L3.

#### 4.3.2.3. Up/Downloading and Transloading Test

(1) When the flatrack of Configuration G was uploaded and downloaded 5 times, the top 17 chess layers shifted backward slightly. This shift was insignificant.

(2) There were no additional shifts when the flatrack was transloaded 5 times.

#### 4.3.3. Road Test for Load Combination F&G

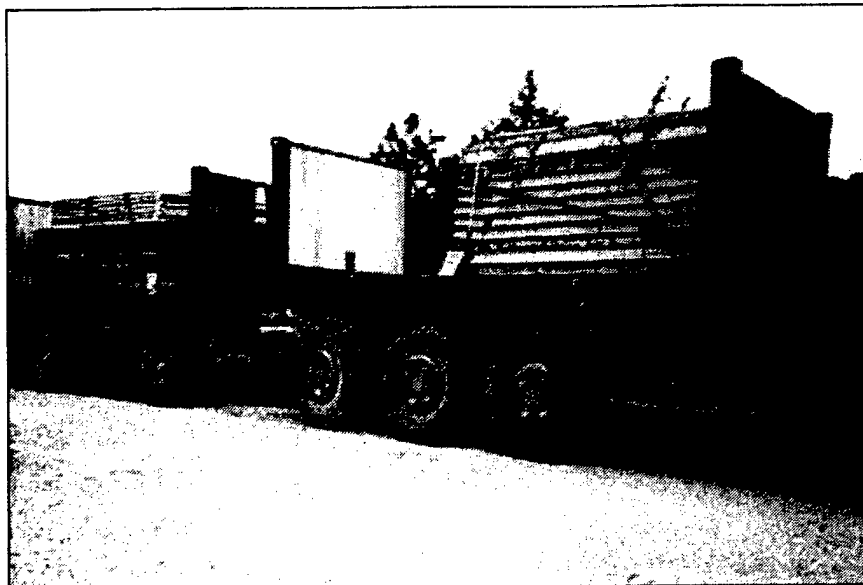
The combination of Configuration F (on the PLS truck) and Configuration G (on the PLS trailer) was hooked up. Two angled-side (left and right) view photographs were taken before the road test. These photographs are displayed in Figures 16 and 17.

The road test for this combination was performed as explained in Paragraph 3.6.2 from (2) to (5). The M2BB components of Flatrack Configurations F and G did not have any additional shifting during the road test.

#### 4.3.4. Repetitive Up/DownLoading and Transloading Test

- (1) After the repetition of five up/downloading and transloading of the Flatrack Configuration F, the ribands on top of the plain ramps shifted backward slightly. This shift was insignificant.
- (2) There were no obvious shifting of components on Flatrack Configuration G during the repetition of five up/downloading and transloading.
- (3) Two photographs of Flatrack Load Configuration G were taken after the repetitive up/downloading and transloading test. These photographs, shown in Figures 18 and 19, indicate an insignificant shift of the chess load.

**FIGURE 16:** LOAD COMBINATION F&G, RIGHT ANGLED-SIDE VIEW



**FIGURE 17:** LOAD COMBINATION F&G, LEFT ANGLED-SIDE VIEW

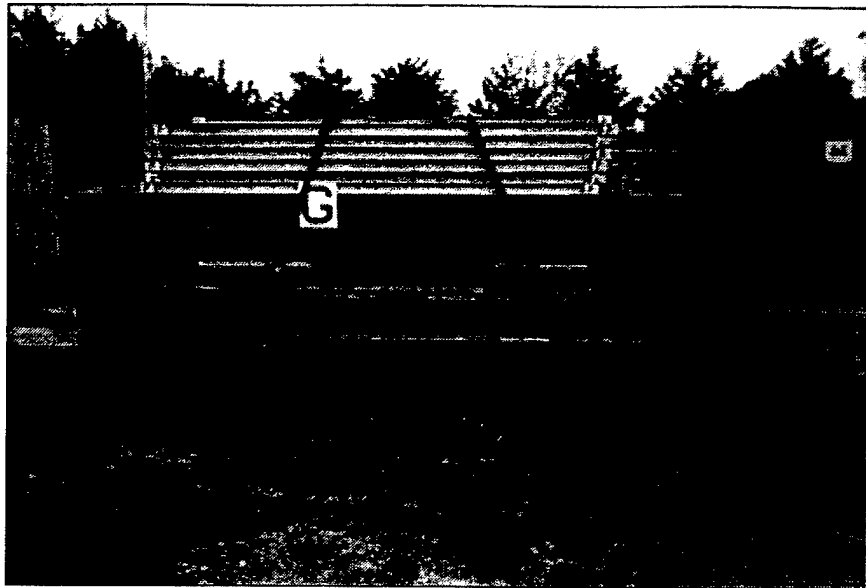


#### 4.3.5. Unloading M2BB Components of Flatrack Configuration G

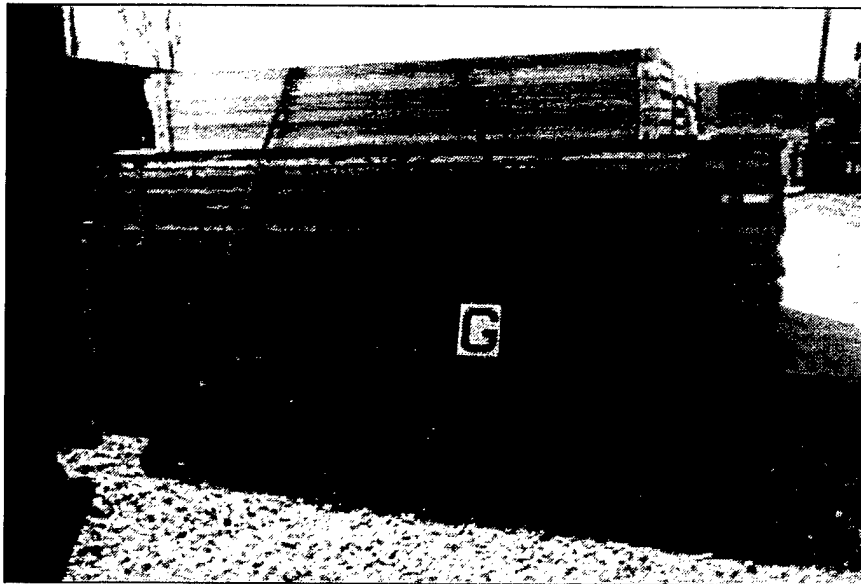
The components of Flatrack Configuration G was untied and removed in the reverse order of the component loading and tiedown described in Paragraph 4.3.2.2. There were no loose components, and no components fell when removing the tiedown. The M1

flatrack used for testing Load Configuration G did not have any damage.

**FIGURE 18:** RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATION G AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



**FIGURE 19:** LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION G AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST





#### 4.4. Flatrack Load Configuration E, F and Load Combination F&E

##### 4.4.1. Flatrack Load Configuration E

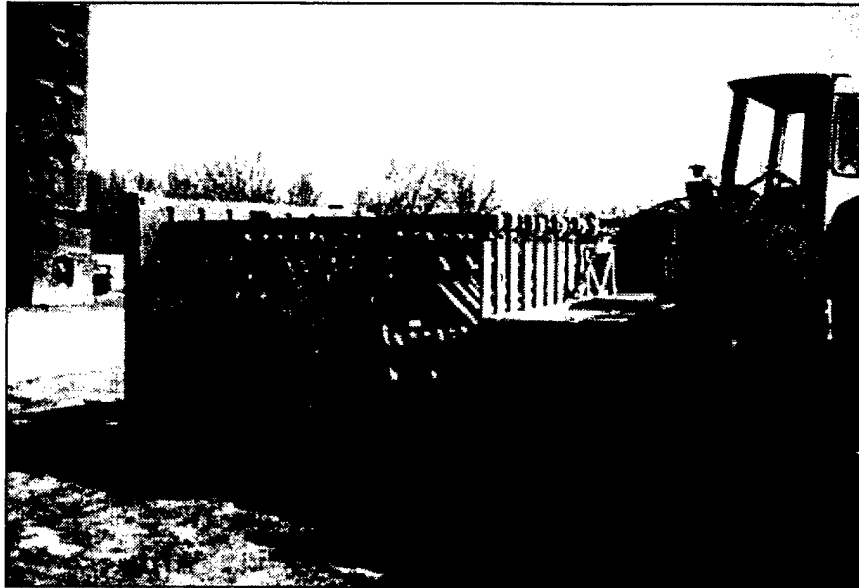
##### 4.4.1.1. Loading M2BB Components for Configuration E

The loading party loaded 9 panels, 25 bracing frames, 8 button ramps, 40 footwalk bearers, 4 base plates, 6 female & 6 male end posts, 8 ramp pedestals, 40 footwalk posts, and 8 bearing shoes on a M1 flatrack and tied them down using 4,536-kg (10,000-lb) rated nylon straps equipped with the flatrack. These components fitted on the M1 flatrack as modeled. However, the bracing frames, footwalk bearers, base plates, end posts, ramp pedestals, footwalk posts, and bearing shoes were located at different positions than shown in the model (Figure 5 of Annex 1). The load height from the flatrack base was measured as 1.85 m (73 in). This height is less than the height of the upright. The flatrack with components of Configuration E weighed 10,052 kg (22,160 lb). The resultant payload of Configuration F is 6,740 kg (14,860 lb). This payload is less than the allowable payload of 7,120 kg (15,700 lb). Two photographs, taken from the left side and right side of the flatrack load after tiedown, are illustrated in Figures 20 and 21. These photographs prove that the components of Configuration E fit within the envelope of the M1 flatrack.

**FIGURE 20: FLATRACK LOAD CONFIGURATION E, RIGHT SIDE VIEW**



**FIGURE 21:** FLATRACK LOAD CONFIGURATION E, LEFT SIDE VIEW



#### 4.4.1.2. Description of Loading and Tiedown Procedures

Several arrangements of the M2BB components (except the panels and button ramps) on the flatrack were tried and the following procedures resulted from the best one.

(1) Stack 9 panels upright on the left side of the flatrack, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is about 5 in from the flatrack edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible. Insert 3 D-handle pickets into the panel lug holes at the rear, one at the top right and 2 at the bottom of both sides. Run a strap from R5 to the bottom ramp end corner, through the picket D-handle on the right and then on the left and to the picket D-handle on the top right of the panel bundle.

(2) Stack 24 bracing frames in the two voids of the panel bundle, each void having 12 bracing frames. Secure these bracing frames with the panels by two straps. The ratchet ends of these two straps must be accessible.

(3) Stack 8 button ramps next to the right side of the panels and stick 40 footwalk bearers in the front and middle voids of the ramp bundle. Place one strap around the top portions of the bearers which protrude above the ramp bundle to secure them with the ramps.

(4) Stack 4 base plates on the right side of the flatrack and behind the ramps.

(5) Place a bracing frame on the top base plate and behind the button ramps. Join 2 straps to make one long strap. Run this strap from FR over the bracing frame at the end of the ramps, over the middle of the rear panel bundle to FL.

(6) Place 6 male end posts and 6 female end posts next to the base plates and right behind the panels. These end posts form 6 layers, each layer has two end posts of the same type.

(7) Stack two boxes, which hold four ramp pedestals in each box, next to the end posts and behind the panels. This should leave a distance of 3 to 4 inches between the bottom box and the flatrack left edge. The inside dimension of this box is 15 x 30 x 56 inches.

(8) Place a box of 40 footwalk posts and 8 bearing shoes on top of the base plates. The inside dimension of this box is 13 x 30 x 56 inches.

(9) Secure these components on the flatrack as follows:

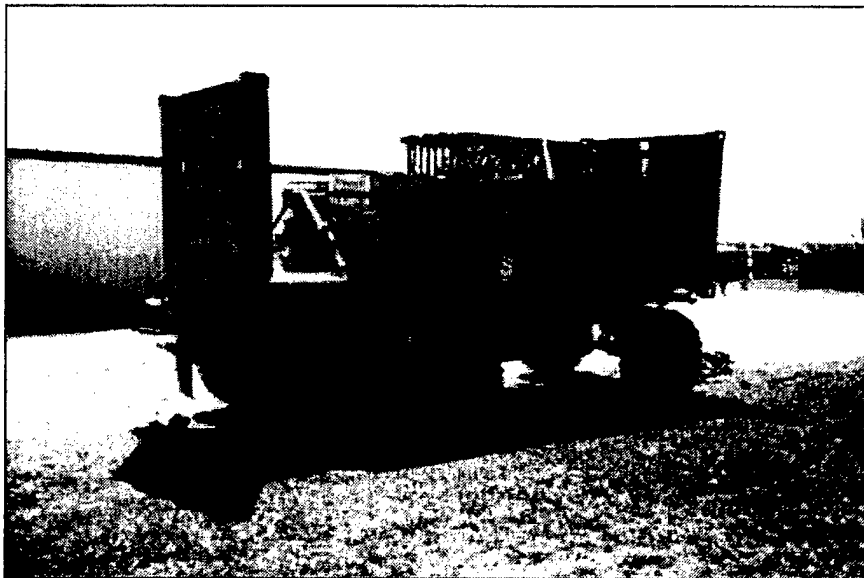
- Run a strap from R1 over the end of the 6<sup>th</sup> ramp (counting from the bottom one), through the panels to R1.
- Crisscross 2 straps over the button ramps and panels from R2 to L6 and from R6 to L2.
- Run one strap from R5, over the button ramps, through the panels and over the bracing frames to L5.
- Run 2 straps over the boxes from R7 to L7 and from R9 to L9.
- Run three straps, one from R8 over the top of the right side box and hook with the end posts, one from L8 over the top of the left side boxes and hook with the end posts, and another one from R9 over the top of the right side box and hook with the end posts.
- Run a strap from R10 over the end of the top end post to L10.
- Run a strap from R7 over the ends of the top boxes to L7.

- Run a strap from R8 through base plate rings right to left, over the top end posts to L7.
- Run a strap from R8 through base plate rings right to left, to the middle end posts, to corner of the bottom box to L9.

#### 4.4.1.3. Up/Downloading and Transloading Test

- (1) The components of Configuration E did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration E did not shift when the flatrack was transloaded 5 times.
- (3) Two photographs, taken after this task, are illustrated in Figures 22 and 23. These photographs indicate that no shifting occurred during the test.

**FIGURE 22:** RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATION E, AFTER THE FIRST UP/DOWNLOADING AND TRANSLOADING TEST



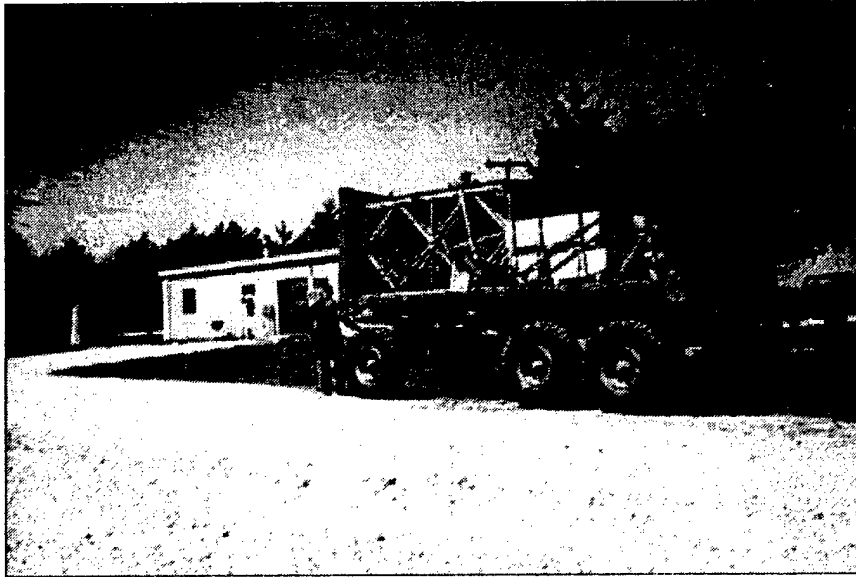
#### 4.4.2. Corrective Action on Flatrack Load Configuration F

##### 4.4.2.1. Corrective Action on Component Loading and Tiedown Procedures

As recorded in Paragraph 4.3.4. (1), the ribands on top of the plain ramps shifted backward slightly after the repetitive

up/downloading and transloading Test of the Flatrack Load Configuration F for 5 times. Even though it was an insignificant shift, a corrective action was performed on this occurrence based on the results of Flatrack Load Configuration E where one bracing frame was used behind the button ramps.

**FIGURE 23:** LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION E, AFTER THE FIRST UP/DOWNLOADING AND TRANSLOADING TEST



A bracing frame was placed behind the plain ramps and the ribands on top of the plain ramps. The joined strap, described in last bullet of Paragraph 4.3.1.2 (6), was connected from FR to the bottom right end corner of the riband on top of the plain ramp, over the bracing frame and to the middle of the vertical member of the left panel of the panel bundle, to FL. This will prevent the ribands on top of the ramps from slipping. Other component loading and tiedown procedures was unchanged. Figure 24 illustrates the use of a bracing frame as explained.

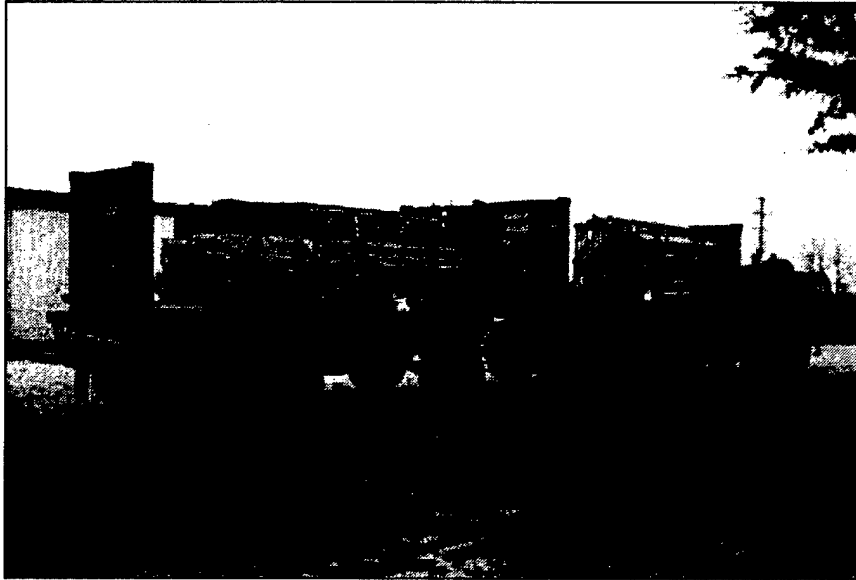
#### 4.4.2.2. Up/Downloading and Transloading Test

- (1) The components of Configuration F did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration F did not shift when the flatrack was transloaded 5 times.

#### 4.4.3. Road Test for Load Combination F&E

The combination of Configuration F (on the PLS truck) and Configuration E (on the PLS trailer) was hooked up. Two angled-side (left and right) view photographs, taken before the road test, are displayed in Figures 24 and 25.

**FIGURE 24:** LOAD COMBINATION F&E, RIGHT ANGLED-SIDE VIEW



**FIGURE 25:** LOAD COMBINATION F&E, LEFT ANGLED-SIDE VIEW

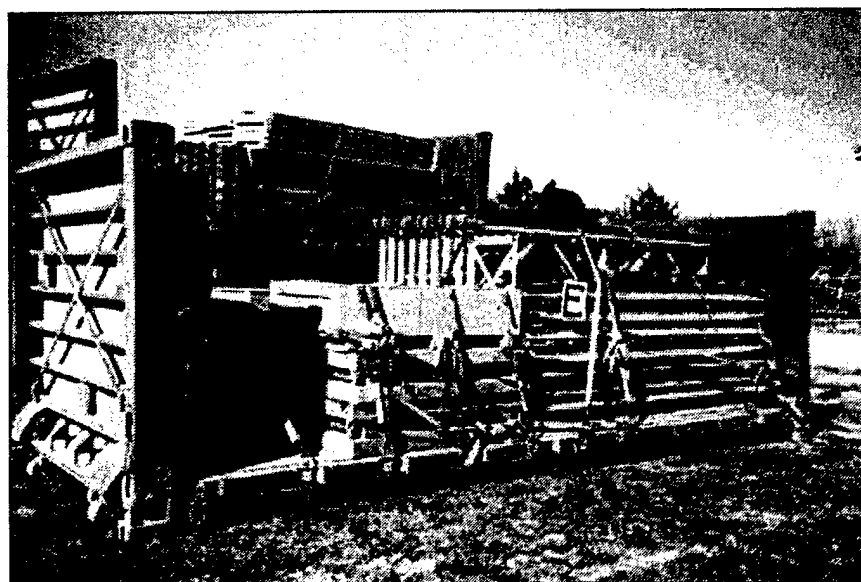


The road test for this combination was performed as explained in Paragraph 3.6.2 from (2) to (5). The M2BB components of Flatrack Configurations E and F did not shift during the road test.

#### 4.4.4. Repetitive Up/DownLoading and Transloading Test

- (1) After the road test, the Flatrack Configuration E was uploaded and downloaded again for 5 times, and also transloaded for 5 times. There were no significant shifting of components on the flatrack.
- (2) After the road test, the Flatrack Configuration F was uploaded and downloaded again for 5 times, and also transloaded for 5 times. There were no significant shifting of components on the flatrack.
- (3) Photographs were taken after the repetitive Up/Downloading and Transloading test. These photographs, displayed in Figures 26, 27, 28, and 29, indicate no occurrence of shifting.

**FIGURE 26:** RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS E AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



**FIGURE 27:** LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS E AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST

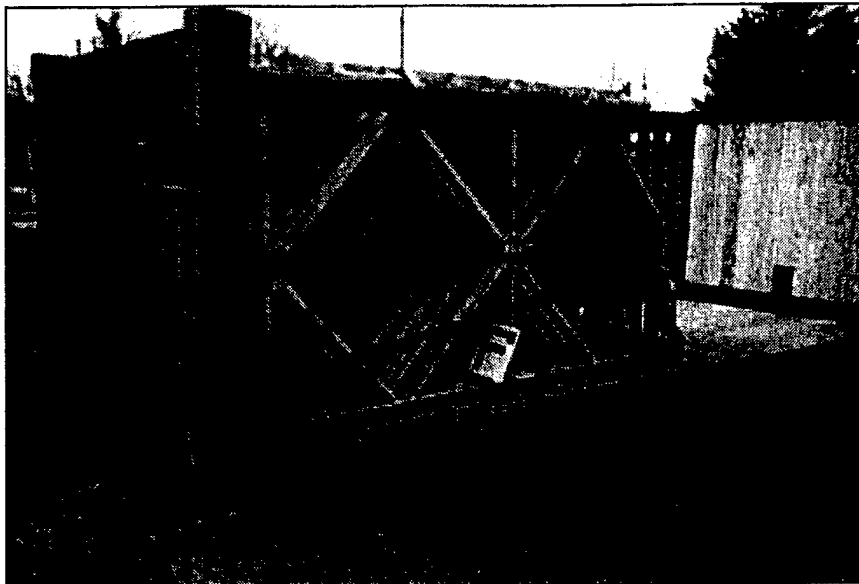


**FIGURE 28:** RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS F AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST





**FIGURE 29: LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATIONS F AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST**



#### 4.4.5. Unloading M2BB Components of Flatrack Configuration E

The components of Flatrack Configuration E were untied and removed in the reverse order of the component loading and tiedown procedures described in Paragraph 4.4.1.2. There were no loose components and no components fell during the tiedown removal. The M1 flatrack did not have any damage.

#### 4.4.6. Unloading M2BB Components of Flatrack Configuration F

The components of Flatrack Configuration F were untied and removed in the reverse order of the component loading and tiedown procedures described in Paragraph 4.3.1.2. There were no loose components and no components fell during the tiedown removal. The M1 flatrack did not have any damage.

#### 4.5. Flatrack Load Configurations A, B and Load Combination B&A

As stated in Paragraph 3.7.1 (1), M2BB erection equipment sets at USAES lacked dimension soft-wood lumber (3 x 6 x 56) and timber soft-wood (6 x 6 x 56). However, the school had 7 x 9 x 96 railroad lumber available. A piece of this lumber was weighed at 104.3 kg (230 lb).

According to Table 2, Load Configuration A and B require 162 dimension soft-wood lumber and 97 timber soft-wood lumber respectively. A piece of dimension soft-wood lumber weighs 8.16 kg (18 lb) and a piece of timber soft-wood lumber weighs 23.59 kg (52 lb). Based on the weights of these lumber, the test used 12 pieces of railroad lumber for Flatrack Load Configuration A and 22 pieces of railroad lumber for Flatrack Load Configuration B in lieu of 162 dimension soft-wood lumber and 97 timber soft-wood lumber respectively.

#### 4.5.1. Flatrack Load Configuration A

##### 4.5.1.1. Loading M2BB Components for Configuration A

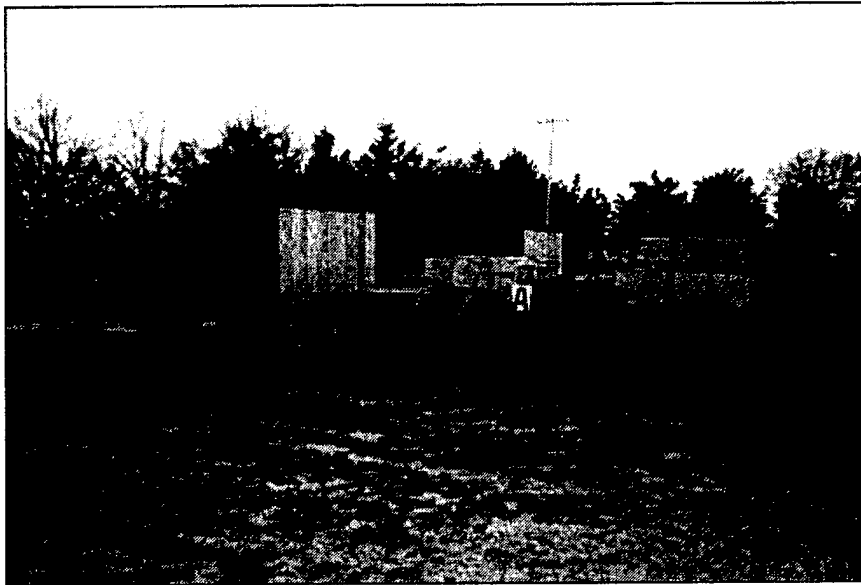
The loading party loaded 18 button stringers, 32 rakers, 12 pieces of railroad lumber, and erection equipment in boxes on a M1 flatrack and tied them down using 4,536 kg (10,000-lb) rated nylon straps equipped with the flatrack. These components fitted on the M1 flatrack as modeled. However, rakers, lumber, and the boxes of erection equipment had a different arrangement on the flatrack than the one shown in Figure 1 of Annex 1, Test Plan for the M-2 Bailey Bridge Palletization. The load height from the flatrack base was measured at 1.56 m (61.5 in). This height is much less than the height of the upright. The flatrack with components of Configuration A weighed 9,607 kg (21,180 lb). The resultant payload of Configuration F is 6,296 kg (13,880 lb). This payload is less than the allowable payload of 7,120 kg (15,700 kg). Two photographs, taken from the left side and right side of the flatrack load after tiedown, are displayed in Figures 30 and 31. These photographs prove that the components of Configuration A fit within the envelope of the M1 flatrack.

##### 4.5.1.2. Description of Loading and Tiedown Procedures

(1) Stack 18 button stringers lengthwise, upright, and against the front upright as modeled. Wrap 2 straps around the inner joined braces of the stringer bundle to hold these stringers together. The ratchet ends of these two straps must be accessible. Run one strap from FR through the upper rear cavity of the button stringer bundle to FL to keep these stringers from sliding backward.

(2) Stack two 15 x 32 x 58 inch boxes of erection equipment on top of the stringer bundle. These two boxes are stacked lengthwise, one next to the other, close to the front upright, and having the same distance from both sides of the flatrack. (There should be four boxes with an inside dimension of 15 x 30 x 56 inches used to store erection equipment with the quantities listed in Table 2, M2BB Palletization Load Configurations, with

**FIGURE 30:** FLATRACK LOAD CONFIGURATION A, RIGHT SIDE VIEW



**FIGURE 31:** FLATRACK LOAD CONFIGURATION A, LEFT SIDE VIEW



the exception of templates, rocking rollers, and panel levels.) Then stack four boxes of rakers lengthwise and close to the front upright on top of the erection equipment boxes. These boxes have the inside dimension of 8 x 10 x 45 inches, each one holds 8 rakers. Run two straps from R2 to L2 and from R3 to L3 to tie these boxes down.

(3) Place six plain roller templates on top of the stringers and behind the two erection equipment boxes to form one layer of two by three templates. This layer occupies an area of 66 inches wide and 54 inches long. Place six rocking rollers lengthwise on top of these templates and run two straps, one from R5 to L5 and one from R6 to L6, to tie these loads down.

(4) Place three panel levers lengthwise on the stringer bundle, one close to the right bundle edge and the other two on the left. Run a strap from R4 over the right lever, over the bundle top between erection equipment boxes and roller templates, over the left levers to L4 to tie these levers down on the stringer bundle.

(5) Lay eight pieces of lumber lengthwise, one next to the other, in the middle of the flatrack, and behind the stringers. Then stack two lumber pieces on the right piece and another two (to make the total number of 12 lumber pieces) on the left piece. Place six rocking roller templates in the cavity formed by this lumber. Crisscross two straps over the top of the lumber and rocking roller templates, one from R7 to L10 and the other from R10 to L7, to tie these loads down on the flatrack.

(6) Place two erection equipment boxes on top of the lumber and rocking roller templates. One of these two boxes has the same dimension as the two erection equipment boxes described above, the other one is shorter with the dimension of 16 x 22 x 40 inches. There were only three boxes available for erection equipment instead of four as required. The shorter box was made up to replace the missing box. Run 2 straps over the top of these erection equipment boxes, one from R7 to L7 and the other from R8 to L8, to tie these loads down. Run a strap from R6 over the back side of the two erection equipment boxes to L6 to keep them from slipping backward.

#### 4.5.1.3. Up/Downloading and Transloading Test

- (1) The components of Configuration A did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration A did not shift when the flatrack was transloaded 5 times.

#### 4.5.2. Flatrack Load Configuration B

##### 4.5.2.1. Loading M2BB for Configuration B

The loading party loaded 9 panels, miscellaneous components in boxes, 8 sway braces, and 22 pieces of railroad lumber on a M1 flatrack and tied them down using 4,536-lb (10,000-lb) rated

nylon straps equipped with the flatrack. These components fitted on the M1 flatrack as modeled. However, the boxes were loaded differently as compared with Figure 2 of Annex 1, Test Plan for the M-2 Bailey Bridge Palletization. The load height from the flatrack base was measured as 1.85 m (73 in). This height is less than the height of the upright. The flatrack with components of Configuration B weighed 9,299 kg (20,500 lb). The resultant payload of Configuration F is 5,987 kg (13,200 lb). This payload is less than the allowable payload of 7,120 kg (15,700 lb). Two photographs, taken from the left side and right side of the flatrack load after tiedown, are displayed in Figures 32 and 33. These photographs prove that the components of Configuration A fit within the envelope of the M1 flatrack.

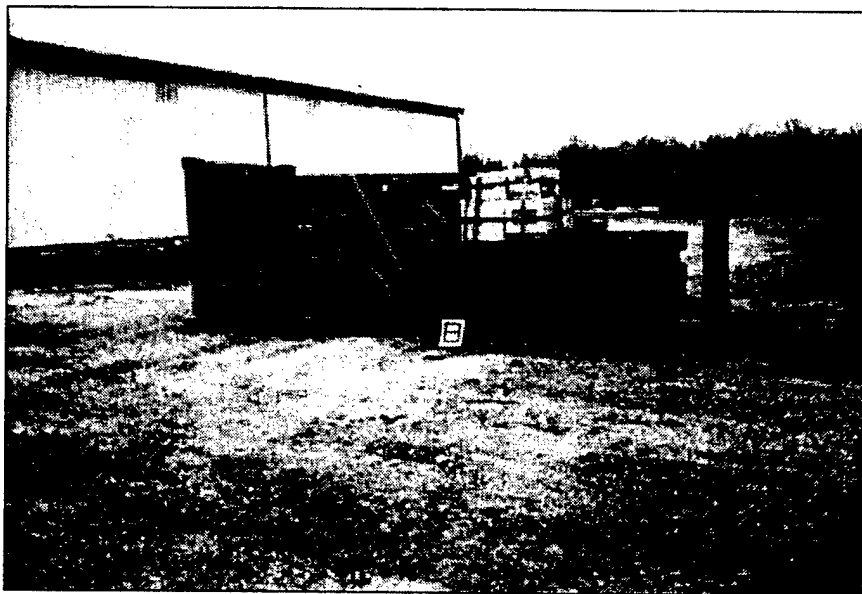
**FIGURE 32: FLATRACK LOAD CONFIGURATION B, RIGHT SIDE VIEW**



#### 4.5.2.2. Description of Component Loading and Tiedown Procedures

(1) Load 9 panels upright, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is 5 in from the flatrack edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible.

**FIGURE 33:** FLATRACK LOAD CONFIGURATION B, LEFT SIDE VIEW



(2) Stack boxes of miscellaneous components alongside the panels, and then place 8 sway braces on top of these boxes.

(3) Stack the lumber lengthwise right behind the panel bundle and miscellaneous equipment boxes. Then stack the remaining boxes of miscellaneous components on top of the lumber and behind the panels.

(4) Secure the panels, miscellaneous boxes, and sway braces as follows:

- Run a strap from R1 over the sway braces and the panel bundle to L1.
- Run a strap from R2 over the load top to L6
- Run a strap from R3 over the top of one box but under the sway braces, through the front cavity of the panel bundle to L3.
- Run a strap from R4 over the sway braces, under the panel top chords, to the center gusset of the left panel to L4.
- Run a strap from R5 over the top of the second box layer, through the panels to L6.
- Run a strap from R6 over the top box layer and under

the sway braces, through the panels to L5.

- Run a strap from R6 through the picket D-handle at the rear top right corner of the panel bundle, to the picket D-handle at the rear top left corner of the panel bundle to L7.
- Run a strap from R7 over the top of boxes, sway braces, and panels to L1.
- Run a strap from R7 over the top box behind the panels to L7.
- Run a strap from R8 over the lumber to L8.
- Run a strap from R8 over the top rear box to L8.
- Run a strap from R8 over the rear side of the top lumber to L7.
- Run a strap from R8 over the rear side of the middle lumber to L8.
- Run a strap from R10 over the lumber top to L10.
- Wrap one strap around the rear boxes of the first box layer behind the panels to hold boxes.
- Wrap one strap around the rear boxes of the second box layer behind the panels to hold boxes.
- Use two straps joined together to hold the side boxes of the third box layer with the panels.
- Join 2 straps to make one long strap. Run this strap from FR to the middle of the rear right edge of the second box layer, to the middle of the rear left edge of the panel bundle to FL.

#### 4.5.2.3. Up/Downloading and Transloading Test

- (1) The components of Configuration B did not shift when the flatrack was uploaded and downloaded 5 times.
- (2) The components of Configuration B did not shift when the flatrack was transloaded 5 times.

#### 4.5.3. Road Test for Load Combination B&A

The combination of Configuration B (on the PLS truck) and Configuration A (on the PLS trailer) was hooked up. Two angled-side (left and right) view photographs, taken before the road test, are displayed in Figures 34 and 35.

**FIGURE 34:** LOAD COMBINATION B&A, RIGHT ANGLED SIDE VIEW



**FIGURE 35:** LOAD COMBINATION B&A, LEFT ANGLED SIDE VIEW



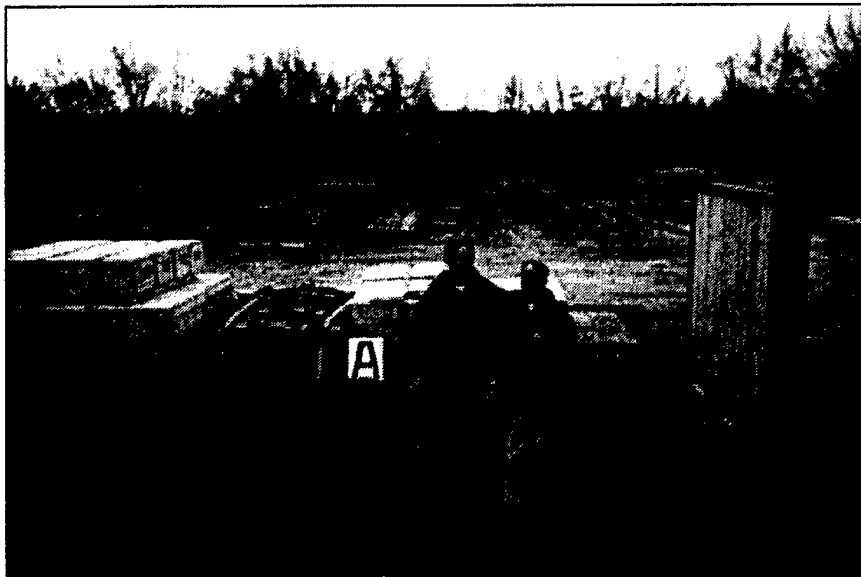


The road test for this combination was performed as described in Paragraph 3.6.2 from (2) to (5). The M2BB components of Flatrack Configurations A and B did not shift during the road test.

#### 4.5.4. Repetitive Up/DownLoading and Transloading Test

- (1) After the road test, the Flatrack Configuration A was uploaded and downloaded again 5 times, and also transloaded 5 times. No shifting of components occurred on the flatrack.
- (2) After the road test, the Flatrack Configuration B was uploaded and downloaded again 5 times, and also transloaded 5 times. No shifting of components occurred on the flatrack.
- (3) Photographs were taken after the repetitive Up/Down-loading and Transloading test. These photographs, displayed in Figures 36, 37, and 38, indicate no occurrence of obvious shifting.

**FIGURE 36:** LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION A AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



**FIGURE 37:** RIGHT SIDE VIEW OF FLATRACK LOAD CONFIGURATION B AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



**FIGURE 38:** LEFT SIDE VIEW OF FLATRACK LOAD CONFIGURATION B AFTER REPETITIVE UP/DOWNLOADING AND TRANSLOADING TEST



#### 4.6. Discussion

The tests showed that the M2BB components can be manually loaded and unloaded from PLS flatracks safely. It also demonstrated that flatrack load configurations shown in Table 2 can be safely uploaded, downloaded, transloaded, and transported. However, improvements on loading and tiedown procedures should be made as discussed below.

(1) When transporting, flatrack loads should be checked after a few miles of travel. All loose straps shall be tightened. For safety, the ratchet ends of straps should be located on the right side of the flatrack. This will keep personnel away from the flow of traffic while adjusting straps. For the straps used to tie components together, their ratchet ends should be accessible. Also, these ratchet ends should be located on the right side of the flatrack if possible.

(2) The panel bundle of Configurations B, C, E, and F can be loaded on the right or left of the flatrack. The location of these panels on the right or on the left of the flatrack does not impact the uploading, downloading, transloading, or transporting of the flatrack.

(3) The use of a bracing frame behind the button ramps of Configuration E and behind the ribands and plain ramps of Configuration F is very effective. The bracing frame keeps the components in place. There should also have been a bracing frame behind the plain stringers of Configuration C.

(4) The tiedown procedures tested for Configuration F as shown in Paragraph 4.3.1.2 (6) included one strap from R6 over the ramps and ribands, through the panels and to L6. It would be more effective to use the strap from R5 to L5.

(5) The test for Configuration G with the tiedown procedures shown in Paragraph 4.3.2.2 did not have any significant shift. However, the following procedures should be used to prevent the chess load and the footwalk load from shifting. These procedures require 7 straps instead of 5.

- Run three straps over the chess load, one from R1 to L1, one from R5 to L5, and the third one from R8 to L8.
- Run two straps over the footwalk load, one from R3 to L3, and the second one from R6 to L6.
- Crisscross two straps over both loads, one from R2 to L7, and the other from R7 to L2.

(6) Boxes to hold M2BB miscellaneous components and erection equipment were necessary for effective palletization.

Boxes of each single item of M2BB miscellaneous components were used for Configuration B. To make the palletization easier for this configuration, there should have been four boxes with an inside dimension of 20 x 23 x 50 inches which could hold all the single miscellaneous component boxes. This would also help if any of the single item boxes were missing.

There should have been four boxes with an inside dimension of 15 x 30 x 56 inches used for M2BB erection equipment of Configuration A with the exclusion of 6 plain roller templates, 6 rocking roller templates, 6 rocking rollers, and 3 panel levers. The previously mentioned erection equipment can be stacked safely without boxes.

(7) Other boxes which should be available are listed as follows:

- Four boxes to store 32 rakers of Configuration A having the inside dimension of 8 x 10 x 45 inches.
- Two boxes to store 8 ramp pedestals of Configuration E having the inside dimension of 15 x 30 x 56 inches.
- One box with the inside dimension of 13 x 30 x 56 inches to store 40 footwalk posts and 8 bearing shoes of Configuration E.

(8) The wood used to make the boxes should be sturdy. Also, the boxes should have a mean to easily carry them, such as rope handles, when they are loaded with components and become heavy.

## 5. CONCLUSIONS

The test demonstrated the following:

- (1) M2BB components fit on the flatrack as modeled.
- (2) Components on each M1 PLS flatrack fit within the envelope of the flatrack.
- (3) M2BB components can be tied down using 4,536-kg (10,000-lb) nylon straps equipped with the flatrack. The PLS flatrack is equipped with 22 straps. The maximum number of straps used was 21 for Configuration E, and the minimum number of straps used was 5 for Configuration G.
- (4) M2BB components are stable in the tested configuration.
- (5) There were no significant shifts of the M2BB components on the flatrack or one on each other when the flatrack was uploaded, downloaded, transloaded, and transported.
- (6) Even though it is difficult to load heavy components on the flatrack without the aid of Materials Handling Equipment, the manual loading of these components can be done.

In general the tested M2BB Palletization Flatrack Load Configurations, using M1/M1077 PLS Flatracks, are effective and safe to use.

## 6. RECOMMENDATIONS

(1) The M2BB Palletization Flatrack Load Configurations using M1/M1077 PLS Flatracks are recommended for use to support the Multi-Role Bridge Company transition.

(2) Boxes for rakers, ramp pedestals, footwalk posts and bearing shoes, miscellaneous components, and erection equipment should be made available for palletization. Sizes of these boxes are listed in Appendix 2, Inside Dimension of Boxes Recommended for the M2BB Palletization.

(3) Loading and tiedown procedures described in Appendix 3 are recommended to be incorporated in the M-2 Bailey Bridge Manual.

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## **8. ATTACHMENT**

### **8.1. Appendices**

- Appendix 1: Personnel Participating in the M2BB Palletization Test
- Appendix 2: Inside Dimension of Boxes Recommended for the M2BB Palletization
- Appendix 3: Recommended Loading and Tiedown Procedures for the M2BB Palletization

## APPENDIX 1

### Personnel Participating in the M2BB Palletization Test

RESPONSIBILITY	NAME	GS/ RANK	ORGANIZATION	PHONE
Engineer, Test Conductor	Nguyen, Anh V.	GS-13	TARDEC	DSN 786-6291
Observer, Material Coordinator	Kniess, Pamela	GS-12	ATCOM	DSN 490-2042
Data Collector, Engineer's Assistant	Sanchez, Eddie E. Montgomery, Don	GS-9 WG-6	SIAD/SIOSI-QA SIAD/SIOSI	DSN 855-4449
PLS Transporter Operator	Miner, Mark Robinson, Dean	SFC SFC	NES-USAES DOTD-USAES	
Loading/ Unloading Party	Hehl, Lawrence	SFC	DCD-USAES	DSN 676-7333
	James, Alton	SFC	TSM-USAES	
	Bivens, Bryce E.	SGT	B Co, 5th Engr	
	Henry, Robert	SPC	B Co, 5th Engr	
	McNutt, Harry	PV2	B Co, 5th Engr	
	Washington, Lutfee	PFC	B Co, 5th Engr	
	Rasp, Paul	PV2	B Co, 5th Engr	
	Scartzel, Brian	PVT	B Co, 5th Engr	
	Chism, Steven	SPC	B Co, 5th Engr	
	Storey, Dustin B.	PV2	B Co, 5th Engr	
	Baker, Brian E.	PVT	B Co, 5th Engr	
	Onimus, John W.	SPC	B Co, 5th Engr	
	Schulze, Charles JR.	PV2	B Co, 5th Engr	
	Bronson, Jacob J.	PVT	B Co, 5th Engr	
	Perkins, Adam J.	SPC	HHC, 5th Engr	
	Ferguson, Mark F.	SPC	B Co, 5th Engr	
Observer, Witness	Guilford, Daniel	CPT	TSM-USAES	DSN 676-6096 573-596-4089
	Baker, Robert	SFC	C co, 577th	
	Davis, Gerald	SFC	C co, 577 <sup>th</sup>	
	McQuillan, Edward	SSG	C co, 577th	
	Hinshaw, Ross D.	SSG	C co, 577th	
	Sides, Jackie A.	GS-9		

## APPENDIX 2

### Inside Dimension of Boxes Recommended for the M2BB Palletization

(1) Following are boxes recommended for the for M2BB components of the basic set. The required quantities of components listed below are for one half of the basic set.

COMPONENT'S NAME	NSN	DIMENSION (IN)	#/BOX	REQD QTY	# OF BOXES
Bracing Bolt	54203556492	12 x 16 x 24	125	250	2
Chord Bolt	54203556493	12 x 12 x 14	050	100	2
Riband Bolt	54203556494	12 x 12 x 40	050	150	3
Transom Clamp	54203556596	12 x 14 x 37	030	150	5
Panel Pin	54203770771	12 x 16 x 33	050	150	3
Short Panel Pin	54203770770	12 x 16 x 28	015	015	1
Sway Brace Pin (in the same box)	54203556781		025	025	
Tie plate	54203556912	08 x 13 x 16	013	013	1
Pin retainer	54200612873	12 x 12 x 14	500	250	2
Tool & Part Bag	54202670058	12 x 14 x 37	010	010	1
Raker	54203556942	08 x 10 x 45	008	032	4
Ramp pedestal	54203719895	15 x 30 x 56	004	008	2
Footwalk post	54203556937	13 x 30 x 56	040	040	1
Bearing shoe (in the same box)	54203556483		008	008	

(2) Four boxes with an inside dimension of 20 x 23 x 50 inches are recommended for loading all the single miscellaneous component boxes which are listed above as 2 boxes of bracing bolts, 2 boxes of chord bolts, 3 boxes of riband bolts, 5 boxes of transom clamps, 3 boxes of panel pins, 1 box of short panel pins and sway brace pins, 1 box of tie plates, 2 boxes of pin retainers, and one box of tool and part bags.

(3) Four boxes with an inside dimension of 15 x 30 x 56 inches are recommended to be used for the following erection equipment: 7 Carrying Bars, 4 Double Blocks, 2 Triple Blocks, 2 Snatch Blocks, 2 Pin Extractors, 6 Double-Face Hammers, 1 Carpenter Hammer, 5 Socket Wrench Handles, 6 Holdfast w/ 9 pickets, 3 Chord Jacks, 5 15-ton Rack Bar Jacks, 12 Launching Nose Links, 5 Rubber Mallets, 3 50-lb boxes Steel Nail, 10 Common Nail Boxes, 3 Guide Roller Assemblies, 2 Transom Rollers, 1 3" Circular Rope, 1 2 1/4" Circular Rope, 2 2" Circular Ropes, 2 Anchor-Type Shackles, 4 Jack Shoes, 2 Sling & Wire Rope Assemblies, 5 1 1/8", 12 PT Sockets, 5 1 7/8", 12 PT Sockets, 9 Steel Anchor Stakes, 6 Plain Rollers, 10 Carrying Tongs, 16 Wood Wedges, 2 Wire Rope Assemblies, 2 3/4", 12 PT Box Wrenches, 5 1 1/8" Open End Wrenches, 5 1 1/2" Open End Wrenches, 5 1 7/8" Open End Wrenches,

10 1 1/8" Single Socket Wrenches. These quantities are for one half of the erection equipment set.

(4) The wood used to make these boxes should be sturdy. These boxes should have a mean to carry them, such as rope handles, when they are loaded with equipment and become heavy. Also, these boxes should have removable lids and should be labeled for component or components to be stored or for purposes to be used.

## **APPENDIX 3**

### **Recommended Loading and Tiedown Procedures for the M2BB Palletization**

The following are the recommended loading and tiedown procedures for M2BB palletization. The following assumptions are used for these procedures:

- M1077 PLS flatracks are used for Configuration D and M1 ISO PLS flatracks for the other configurations.
- The boxes described in Appendix 2, Inside Dimension of Boxes Recommended for the M2BB Palletization, are used.
- The 4,536-kg (10,000-lb) rated nylon straps equipped with M1/M1077 flatracks are used.
- The ratchet end of all the straps using tiedown rings are located on the right side of the flatrack.

The unloading procedures are in the reverse order of the loading and tiedown procedures.

#### **1. Flatrack Load Configuration A**

1.1. Components will be loaded on the M1 flatrack are 32 rakers, 18 button stringers, 162 dimension soft-wood lumber, and erection equipment. It is noted that four boxes will be used for erection equipment, and these boxes will not include plain roller templates, rocking roller templates, rocking rollers, and panel levers. The minimum number of straps used for this configuration is 15. Care should be taken when loading components on the flatrack.

##### **1.2. Procedures:**

1.2.1. Step 1: Lay 18 button stringers lengthwise on the flatrack deck area, upright, and against the front upright. Wrap 2 straps around the inner joined braces of the stringer bundle to hold these stringers together. The ratchet ends of these two straps must be accessible. Join two straps to make a long straps. Run the joined strap from FR through the upper rear cavity of the button stringer bundle to FL to keep these stringers from sliding backward.

1.2.2. Step 2: Lay 162 pieces of soft-wood lumber lengthwise on the flatrack and right behind the stringers forming 11 layers of lumber. The first ten layers contain 15 pieces per layer and the top one contains 12 pieces. These twelve pieces of lumber will be laid in such a way that each piece will be approximately 0.04 m (1.5 in) from the next one and the outside pieces will be aligned with the outside ones of the other layers. Run two straps over the lumber load from R7 and R9 to L7 and L9 respectively to tie the lumber on the flatrack.

1.2.3. Step 3: Stack four boxes of erection equipment on top of the stringer bundle. These four boxes are stacked lengthwise to form two lines, one at the left side and the other at the right side of the flatrack. Each line contains 2 boxes, one behind the other, and the front end of each front box is located close to the front upright. (In the case of manual loading, place four empty boxes on the stringers, fill these boxes with erection equipment, and then close their lids.) Place six plain roller templates and six rocking rollers in the cavity formed by two lines of erection equipment boxes, the templates on the stringers first and then the rollers on the templates. Run four straps over these loads from R2, R3, R4, and R5 to L2, L3, L4, and L5 respectively, and crisscross two straps over these loads from R1 and R6 to L6 and L1 respectively to tie them down.

1.2.4. Step 4: Place four boxes of rakers, six rocking roller templates, and three panel levers on top of the lumber and run three straps over the top of these loads from R7, R8, and R9 to L7, L8, and L9 respectively to tie them down.

## **2. Flatrack Load Configuration B**

2.1. Components will be loaded on the M1 flatrack are 9 panels, 8 sway braces, 97 timber soft-wood lumber, and miscellaneous components. It is noted that four boxes will be used for miscellaneous components, and boxes of all single miscellaneous components will be placed in these four boxes. The minimum number of straps used for this configuration is 14. Care should be taken when loading components on the flatrack.

### **2.2. Procedures:**

2.2.1. Step 1: Stack 9 panels on the flatrack deck area upright, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is approximately 0.13 m (5 in) from the flatrack left edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other

around their rear side gussets. The ratchet ends of these two straps must be accessible.

2.2.2. Step 2: Use four boxes to load boxes of miscellaneous components, and stack these four boxes alongside the panels to make two layers, each one contains two boxes. (In the case of manual loading, place two empty boxes of miscellaneous components along side the panels. Fill these boxes with boxes of miscellaneous components and close their lids. Place the other two boxes on top of the loaded boxes, fill them with the remaining boxes of miscellaneous components, and close their lids.) Run four straps from R2, R3, R4, and R5 over the top of these boxes, through the cavity of the panel bundle to L2, L3, L4, and L5 respectively to tie these four boxes on the flatrack.

2.2.3. Step 3: Place 8 sway braces on top of the miscellaneous component boxes. Run two straps from R1 and R6 over the sway braces, through the cavity of the panel bundle to L1 and L6 respectively to tie these braces on the boxes.

2.2.4. Step 4: Insert two D-handle pickets into the panel lug holes at the rear of the panel bundle, one at the top right corner and the other at the top left corner. Run a strap from R6 through the D-handle of both pickets to L6. These pickets will keep the panels from slipping. Join 2 straps to make one long strap. Run the joined strap from FR to the middle of the rear right edge of the second box layer, to the middle of the rear left edge of the panel bundle to FL to keep the panels from shifting backward.

2.2.5. Step 4: Lay 97 pieces of soft-wood lumber lengthwise on the flatrack and right behind the panels forming 7 layers of lumber. The first six layers contain 15 pieces per layer and the top one contains 7 pieces which are located in the middle of the other layers. . Run three straps over the lumber load from R7, R8, and R9 to L7, L8, and L9 respectively to tie the lumber on the flatrack.

### **3. Flatrack Load Configuration C**

3.1. Components will be loaded on the M1 flatrack are 9 panels, 12 plain stringers, and 8 sway braces. It is noted that a bracing frame will be placed behind the plain stringers to keep these stringer from shifting. The minimum number of straps used for this configuration is 9. Care should be taken when loading components on the flatrack.

### 3.2. Procedures:

3.2.1. Step 1: Stack 9 panels upright on the flatrack deck area, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is 0.13 m (5 in) from the flatrack right edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible.

3.2.2. Step 2: Stack 12 plain stringers lengthwise one on top the other next to the panels. Place 8 sway braces on top of the plain stringers. Insert two D-handle pickets into the panel lug holes at the rear of the panel bundle, one at the top right corner and the other at the top left corner. Run a strap from R6 through the D-handle of both pickets to L6. These pickets will keep the panels from slipping.

3.2.3. Step 3: Secure these components on the flatrack using 4 straps as follows:

- Run two straps from R3 and R5 through the panel bundle cavity, over the sway braces and stringers to L3 and L5 respectively.
- Crisscross two straps from R1 and R7 over the panels, sway braces, and stringers to L7 and L1 respectively.

3.2.4. Step 4: Place a bracing frame upright on the flatrack and right behind the plain stringer bundle. Join two straps to make a long strap and run the joined strap from FR, midway up the rear vertical member of the outer panel, parallel with the deck surface, around the bracing frame to FL. This tiedown keeps the panels and stringers from shifting backward.

## 4. Flatrack Load Configuration D

4.1. Components will be loaded on the M1077 flatrack are 28 transoms. The minimum number of straps used for this configuration is 11. Care should be taken when loading transoms on the flatrack.

### 4.2. Procedures:

4.2.1. Step 1: Lay 14 transoms on the flatrack deck area lengthwise and side by side to form a layer. The outer transom of this transom layer is 0.36 m (14 in) from the edge of the flatrack. Use 2 pieces of 3 x 6 x 54 lumber between the A-frame



and the front end of the transom layer as a barrier for aligning the transoms against the A-frame. Secure this layer on the flatrack using four straps as follows:

- Run one strap from R9 through the 6<sup>th</sup> (end) web holes of the transoms to L9.
- Run one strap from R8 through the 4<sup>th</sup> web holes of the transoms to L8.
- Run one strap from R2 through the 3<sup>rd</sup> web holes of the transoms to L2.
- Run one strap from R3 through the first web holes of the transoms to L3.

4.2.2. Step 2: Place 4 pieces of 3 x 6 x 54 lumber on top of the other two pieces at the A-frame forming three rows of lumber. These lumber will serve as a barrier for aligning the second layer of transoms against the A-frame. Put 8 pieces of 3 x 6 x 54 lumber on top of the first transom layer crosswise to make 4 overlapped crossing rows. The distance between each row and between the first row at the A-frame is approximately 40 inches. Then, load 14 transoms to form a second transom layer exactly the same as the first one. Secure the second layer transoms using four straps as follows:

- Run one strap from R9 through the 6<sup>th</sup> (end) web holes of the second layer transoms to L9.
- Run one strap from R8 through the 4<sup>th</sup> web holes of the second layer transoms to L8.
- Run one strap from R2 through the 3<sup>rd</sup> web holes of the second layer transoms to L2.
- Run one strap from R3 through the first web holes of the second layer transoms to L3.

4.2.3. Step 3: Secure both transom layers on the flatrack using three straps as follows:

- Run two straps, one from R1 over the second transom layer to L1 and the other from R11 over the second transom layer to L11. These two straps are placed behind the transom lugs.
- Run one strap from R6 over the second transom layer to L6.

## **5. Flatrack Load Configuration E**

5.1. Components will be loaded on the M1 flatrack are 9 panels, 19 bracing frames, 8 button ramps, 8 ramp pedestals, 4 base plates, 6 female end posts, 6 male end posts, 40 footwalk bearers, 40 footwalk posts, and 8 bearing shoes. The minimum number of straps used for this configuration is 21. Care should be taken when loading components on the flatrack.

### **5.2. Procedures:**

5.2.1. Step 1: Stack 9 panels upright on the left side of the flatrack, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is about 0.13 m (5 in) from the flatrack edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible.

5.2.2. Step 2: Stack 18 bracing frames in the two voids of the panel bundle, each void having 9 frames. Secure these bracing frames with the panels by two straps. The ratchet ends of these two straps must be accessible.

5.2.3. Step 3: Stack 8 button ramps next to the right side of the panels and stick 40 footwalk bearers in the front and middle voids of the ramp bundle. Place one strap around the top portions of the bearers which protrude above the ramp bundle to secure them with the ramps.

5.2.4. Step 4: . Insert two D-handle pickets into the panel lug holes at the rear of the panel bundle, one at the top right corner and the other at the top left corner. Run one strap from R6 through the D-handle of both pickets to L6. These pickets will keep the panels from slipping.

5.2.5. Step 5: Stack 4 base plates on the right side of the flatrack and behind the ramps. Place a bracing frame on the top base plate and behind the button ramp. Join 2 straps to make one long strap. Run the joined strap from FR over the bracing frame at the end of the ramps, over the middle of the rear panel bundle to FL.

5.2.6. Step 6: Place 6 male end posts and 6 female end posts next to the base plates and right behind the panels. These end posts form 6 layers, each layer has two end posts of the same type.

5.2.7. Step 7: Stack two boxes, which hold four ramp pedestals in each box, next to the end posts and behind the panels. This should leave a distance of 0.08 to 0.10 m (3 to 4 in) between the bottom box and the flatrack left edge. (In the case of manual loading, stack the empty boxes first, place pedestals in the boxes, and close their lids.)

5.2.8. Step 8: Place a box of 40 footwalk posts and 8 bearing shoes on top of the base plates. (In the case of manual loading, place the empty box on the base plates first, load it with footwalk posts and bearing shoes, and close its lid.)

5.2.9. Step 9: Secure all the components on the flatrack using 13 straps as follows:

- Run one strap from R1 over the end of the 6<sup>th</sup> ramp (counting from the bottom one), through the panels to R1.
- Crisscross two straps over the button ramps and panels from R2 and R6 to L6 and L2 respectively.
- Run one strap from R5, over the button ramps, through the panels and over the bracing frames to L5.
- Run two straps over the boxes from R7 and R9 to L7 and L9 respectively.
- Run three straps, one from R8 over the top of the right side box and hook with the end posts, one from L8 over the top of the left side boxes and hook with the end posts, and another one from R9 over the top of the right side box and hook with the end posts.
- Run one strap from R10 over the end of the top end post to L10.
- Run one strap from R7 over the ends of the top boxes to L7.
- Run one strap from R8 through base plate rings right to left, over the top end posts to L7.
- Run one strap from R8 through base plate rings right to left, to the middle end posts, to corner of the bottom box to L9.

## **6. Flatrack Load Configuration F**

6.1. Components will be loaded on the M1 flatrack are 9 panels, 8 plain ramps, 12 ribands. The minimum number of straps used for this configuration is 11. Care should be taken when loading components on the flatrack.

## 6.2. Procedures:

6.2.1. Step 1: Stack 9 panels upright on the left side of the flatrack, side by side with the same type of lugs (male or female) at each end. One end of these nine panels is against the front upright, and the outer panel is 0.13 m (5 in) from the flatrack edge. Secure these panels together by two straps, one wrapped around their center gussets, and the other around their rear side gussets. The ratchet ends of these two straps must be accessible.

6.2.2. Step 2: Stack 8 plain ramps lengthwise one on top the other next to the panels. Stack 8 ribands on top of these ramps with two straps wrapped around the riband bundle, each one located approximately 1.0 m (40 in) from each riband bundle end. The ratchet ends of these two straps must be accessible. Run two straps from R2 and R5 over the ramps and ribands, through the panels to L2 and L5 respectively.

6.2.3. Step 3: Insert two D-handle pickets into the panel lug holes at the rear of the panel bundle, one at the top right corner and the other at the top left corner. Run one strap from R6 through the D-handle of both pickets to L6. These pickets will keep the panels from slipping.

6.2.4. Step 4: Join 2 straps to make one long strap. Place a bracing frame behind the plain ramps and the ribands on the ramps. Run the joined strap from FR over the bracing frame at the end of the ramps, over the middle of the rear panel bundle to FL. This tiedown will keep the panels, ramps, and ribands on the ramps from shifting backward.

6.2.5. Step 5: Bolt the remaining ribands with bracing bolts to make 2 pairs. Stack these two riband pairs on top of the panels lengthwise and at the middle of the panels. Put 2 pickets behind the riband pairs to keep them from moving backward. Secure all the components on the flatrack by crisscrossing two straps from R1 and R6 over the complete load to L6 and L1 respectively.

## 7. Flatrack Load Configuration G

7.1. Components will be loaded on the M1 flatrack are 185 chess and 18 footwalks. The minimum number of straps used for this configuration is 7. Care should be taken when loading components

on the flatrack especially when loading footwalks on top of the chess bundle.

## 7.2. Procedures:

7.2.1. Step 1: Stack 18 layers of chess on the M1 flatrack with one end of these layers about 0.03 m (1 in) from the A-frame of this flatrack. Each layer contains 10 chess. The outer chess of the bottom layer is about 0.04 m (1.5 in) from the flatrack edge of each side. Then lay the remaining 5 chess on top of the top layer spaced apart approximately 0.22 m (8.5.in). The distance from one outer chess of these 5 chess to the top layer edge of each side is also 0.22 m (8.5 in.). The ends of these chess are even with the other chess ends. Secure the chess load by 3 straps from R1, R5, and R8 to L1, L5, and L8 respectively.

7.2.2. Step 2: Stack three bundles of footwalks on top of the chess load in the middle of the top area. Each bundle contains 6 footwalks. Secure the footwalk bundles on the chess load by two straps from R3 and R6 to L3 and L6 respectively. Secure the complete load on the flatrack by crisscrossing two straps R2 and R7 to L7 and L2 respectively.

## 8.2. Annex

## **ANNEX 1**

### **Test Plan for the M-2 Bailey Bridge Palletization**



**TEST PLAN**  
**FOR**  
**THE M-2 BAILEY BRIDGE**  
**PALLETIZATION**

**US ARMY TACOM/TARDEC**  
**ENGINEER & LOGISTICS EQUIPMENT BUSINESS AREA**  
**SUPPORT BRIDGE TEAM**  
**AMSTA/TR/R/21**



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## TABLE OF CONTENTS

1. BACKGROUND .....	1
2. TEST OBJECTIVES .....	2
3. TEST CRITERIA .....	3
4. TEST PROCEDURES .....	4
4.1. Inspection of Test Equipment.....	4
4.2. Inspection of M2BB Components.....	4
4.3. Flatrack Load Combinations for Testing.....	4
4.4. General Test Procedures for each Flatrack Load Configuration and Combination.....	4
4.4.1. Before road test .....	4
4.4.2. Road test .....	5
4.4.3. After road test .....	5
4.5. Preventive Maintenance Checks and Services (PMCS).....	5
4.6. Detailed Test Procedures.....	6
4.6.0. Inspection and Weighing .....	6
4.6.1. Flatrack Load Combination A&B Test .....	6
4.6.2. Flatrack Load Combination D&C Test .....	8
4.6.3. Flatrack Load Combination F&E Test .....	9
4.6.4. Flatrack Load Combination F&G Test .....	11
5. REQUIRED MATERIEL RESOURCES .....	13
5.1. Test location.....	13
5.2. Materials.....	13
5.3. Personnel.....	13
6. COORDINATION LIST .....	14
7. TEST SCHEDULE .....	15
8. ATTACHMENTS .....	16
(1) Attachment 1: M-2 Bailey Bridge Palletization Flatrack Load Configuration Using M1/M1077 Flatracks	
(2) Attachment 2: Computer Models of M2BB Palletization Flatrack Loads	
(3) Attachment 3: Required Material Resources	
(4) Attachment 4: Road Test Map	
(5) Attachment 5: M2BB Palletization Test Schedule	
(6) Attachment 6: Data Collection Sheets	

## **M-2 BAILEY BRIDGE PALLETIZATION TEST PLAN**

### **1. BACKGROUND**

Total Army Analysis 2001 (TAA01) authorizes a total of 21 bridge companies. The Army Engineering School (USAES) proposes that these remaining companies be configured into Multi-Role Bridge Companies (MRBCs) which would be capable of spanning both wet- and dry-gaps. To facilitate the move to the MRBC, a common transporter for both the Ribbon Bridge (RB) and the Heavy Dry Support Bridge (HDSB) is required. This transporter, the Common Bridge Transporter (CBT), is based on the Heavy Expanded Mobility Tactical Truck (HEMTT) chassis and is Palletized Loading System (PLS) capable.

Currently, the United States has 142 M-2 Bailey Bridge (M2BB) Basic sets and 65 M2BB Erection Equipment sets. Current doctrine requires one panel bridge engineer company to transport one M2BB Basic set and one M2BB Erection Equipment set which contains enough components to install two 80-foot double-single (DS) bridges with launching nose or one 130-foot double-double (DD) bridge with launching nose.

To support the transition of M2BB to MRBC, the Support Bridge Team has developed the Palletized Loading System (PLS) flatrack load configurations for an M2BB Basic set and an M2BB Erection Equipment set using M1/M1077 flatracks. These configurations are illustrated in Attachment 1, M-2 Bailey Bridge Palletization Flatrack Load Configuration Using M1/M1077 Flatracks, and Attachment 2, Computer Models of M2BB Palletization Flatrack Loads.

## 2. TEST OBJECTIVES

The objectives of the test are to verify the M-2 Bailey Bridge Palletization Flatrack Load Configuration using M1/M1077 Flatracks and to assure these loads can be uploaded, downloaded, transloaded, and transported safely. Specific objectives are:

- (1) Can M2BB components fit on the flatrack as modeled?
- (2) Can M2BB components be tied down using twenty two (22) 10,000-lb nylon straps?
- (3) Are M2BB components stable in the model configuration?
- (4) Can loaded flatracks be uploaded, downloaded, transloaded, and transported safely? (It is unsafe if components excessively shift or move during uploading, downloading, transloading or transporting.)
- (5) Is it difficult to load/unload components on and off the flatrack without the aid of Materials Handling Equipment?

### 3. TEST CRITERIA

- (1) The M2BB components of Load Configurations A, B, C, E, F, and G will fit onto the useable deck area (2.44 x 5.64 m) of the PLS ISO Flatrack M1.
- (2) The transoms of Configuration D will fit within the width of the PLS Flatrack M1077 and will overhang 0.23 m off its rear.
- (3) The load height of each Load Configuration will not exceed 2.44 m from the flatrack base.
- (4) M2BB components will be secured by being tied down with web straps (10,000-lb rated) using the tiedown rings of the PLS flatrack. Other tiedown methods will not be allowed.
- (5) M2BB components will not shift on each other during uploading, downloading, transloading, and transporting.
- (6) M2BB components will not shift on the deck area of the PLS flatrack during uploading, downloading, transloading, and transporting.
- (7) M2BB components will not shift on each other during emergency braking or during hard turning maneuvers.
- (8) M2BB components will not shift on the deck area of the PLS flatrack during emergency braking or during hard turning maneuvers.

## 4. TEST PROCEDURES

### 4.1. Inspection of Test Equipment

- (a) M1 ISO PLS Flatracks
- (b) M1077 PLS Flatrack
- (c) M1075 PLS Transporter
- (d) M1076 PLS Trailer

The inspection will include weighing of each test flatrack and vehicle.

### 4.2. Inspection of M2BB Components

- (a) Components of the M2BB Basic set.
- (b) Components of the M2BB Erection Equipment set.

### 4.3. Flatrack Load Combinations for Testing

Each flatrack load configuration illustrated in Attachment 1, M-2 Bailey Bridge Palletization Flatrack Load Configuration Using M1/M1077 Flatracks, will be verified/tested for loading, unloading (removing), uploading, downloading, and transloading. Combinations of two load configurations will be tested for transportation. Flatrack Load Combinations to be tested are shown below:

Combination	Flatrack (PLS Truck)	Flatrack (PLS Trailer)	Notes
-----	-----	-----	-----
A&B	A	B	M1/M1
D&C	D	C	M1077/M1
F&E	F	E	M1/M1
F&G	F	G	M1/M1

### 4.4. General Test Procedures for each Flatrack Load Configuration and Combination

#### 4.4.1. Before road test

(a) Load and tiedown M2BB components on PLS Trailer Flatrack. Document if components do not fit as modeled. Measure the highest load height from the flatrack base. Document tiedown procedures. Take two side (left and right) view photographs of load. (In case of the M1077 PLS Flatrack, take an additional photograph for end view.)

(b) Upload & download PLS Trailer Flatrack five (5) times. Inspect load for shifting. Transload PLS Trailer Flatrack to and from the trailer five (5) times. Inspect load for shifting. Take photographs if load shifting occurs.

(c) Load and tiedown M2BB components on PLS Truck Flatrack. Document if components do not fit as modeled. Measure the highest load height from the

flatrack base. Document tiedown procedures. Take two side (left and right) view photographs of load. (In case of the M1077 PLS Flatrack, take an additional photograph for end view.)

(d) Upload & download PLS Truck Flatrack five (5) times. Inspect load for shifting. Transload PLS Truck Flatrack to and from the trailer five (5) times. Inspect load for shifting. Take photographs if load shifting occurs.

#### **4.4.2. Road test**

(a) Download PLS Truck Flatrack. Upload and transload PLS Trailer Flatrack onto the PLS Trailer. Upload PLS Truck Flatrack and connect with PLS Trailer Flatrack. Take two angled-side (left and right) view photographs.

(b) Roadmarch 5 km on hard surface roads. Stop and weigh loads at scales. Inspect load for shifting.

(c) Road march 5 km on unimproved roads. Inspect load for shifting.

(d) Conduct emergency braking test on hard surface roads. Inspect load for shifting.

(e) Conduct turning test on hard surface roads. Inspect load for shifting.

#### **4.4.3. After road test**

(a) Disconnect PLS Trailer Flatrack and download PLS Truck Flatrack.

(b) Transload PLS Trailer Flatrack five (5) times. Inspect load for shifting. Download and upload PLS Trailer Flatrack five (5) times. Inspect load for shifting. Take two side (left and right) view photographs of PLS Trailer Flatrack. (In case of the M1077 PLS Flatrack, take an additional photograph for end view.)

(c) Transload PLS Truck Flatrack five (5) times. Inspect load for shifting. Download and upload PLS Truck Flatrack five (5) times. Inspect load for shifting. Take two side (left and right) view photographs of PLS Truck Flatrack. (In case of the M1077 PLS Flatrack, take an additional photograph for end view.)

(d) Remove M2BB components from PLS Trailer Flatrack. Document all loose parts and parts that fall when removing tiedowns. Take photographs of fallen components, if any.

(e) Remove M2BB components from PLS Truck Flatrack. Document all loose parts and parts that fall when removing tiedowns. Take photographs of fallen components, if any.

(f) Inspect PLS Flatracks for damage. Take photographs to show damages, if any.

#### **4.5. Preventive Maintenance Checks and Services (PMCS)**

Conduct PMCS for the M1 ISO PLS Flatracks, the M1077 PLS Flatrack, the M1075 PLS Transporter, and the M1076 PLS Trailer every morning before conducting the test.

## 4.6. Detailed Test Procedures

### 4.6.0. Inspection and Weighing

The following tasks will be performed one time only and before the test.

- (1) Inspect all test equipment including the M1 ISO PLS Flatracks, the M1077 PLS Flatrack, the M1075 PLS Transporter, and the M1076 PLS Trailer and record the results.
- (2) Weigh each flatrack (without any load on it) and record its weight.
- (3) Weigh the PLS transporter and record its weight.
- (4) Weigh the PLS trailer and record its weight.
- (5) Inspect components of the M2BB Basic set and record the results.
- (6) Inspect components of the M2BB Erection Equipment set and record the results.

### 4.6.1. Flatrack Load Combination A&B Test

#### 4.6.1.1. Loading M2BB components of Configuration A onto an empty M1 flatrack

- (1) The M1 flatrack is on the ground.
- (2) Load and tiedown M2BB components of Configuration A onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take two side (left and right) view photographs of this load.

#### 4.6.1.2. Loading M2BB components of Configuration B on an empty M1 flatrack

- (1) The M1 flatrack is on the ground.
- (2) Load and tiedown M2BB components of Configuration B onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take two side (left and right) view photographs of this load.

#### 4.6.1.3. Uploading and downloading PLS Truck Flatrack (with components of Configuration A)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U. (U: uploading, D: downloading)
- (2) Inspect load for shifting and record the results.

#### 4.6.1.4. Transloading PLS Truck Flatrack (with components of Configuration A)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T-F. (T: to, F: from)
- (2) Inspect load for shifting and record the results.
- (3) Download the flatrack.

#### 4.6.1.5. Uploading and downloading PLS Trailer Flatrack (with components of Configuration B)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U.
- (2) Inspect load for shifting and record the results.



#### 4.6.1.6. Transloading PLS Trailer Flatrack (with components of Configuration B)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. (The flatrack is now on the trailer.)
- (2) Inspect load for shifting and record the results.

#### 4.6.1.7. Road Test

##### 4.6.1.7.1. Road-marching

- (1) Upload PLS Truck Flatrack (with components of Configuration A) and connect to PLS Trailer Flatrack (with components of Configuration B).
- (2) Take two angled-side (left and right) view photographs.
- (3) Road-march 5 km on hard surface roads.
- (4) Stop, inspect load for shifting, and record the results.
- (5) Weigh the combination and record each weight as follows:
  - (a) the front tandem of the truck without the trailer,
  - (b) the rear tri-axle of the truck without the trailer, and
  - (c) the trailer.
- (6) Road-march 5 KM on un-improved roads.
- (7) Stop, inspect load for shifting, and record the results.

##### 4.6.1.7.2. Emergency braking test

Apply one hard stop on a hard surface road, inspect load for shifting, and record the results.

##### 4.6.1.7.3. Turning test

- (1) Conduct turning test for a turning radius of 36.5 m wall-to-wall.
- (2) Stop, inspect load for shifting, and record the results.

#### 4.6.1.8. Repeating downloading, uploading, and transloading

- (1) Unhook the trailer and download PLS Truck Flatrack (with components of Configuration A).
- (2) Transload PLS Trailer Flatrack (with components of Configuration B) from and to the trailer in the sequence of F-T-F-T-F-T-F-T-F. Inspect load for shifting and record the results. Download and upload PLS Trailer Flatrack in the sequence of D-U-D-U-D-U-D-U-D. Inspect load for shifting, and record the results. Take two side (left and right) view photographs of PLS Trailer Flatrack.
- (3) Upload PLS Truck Flatrack (with components of Configuration A) and transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. Inspect load for shifting and record the results. Download and upload PLS Truck Flatrack in the sequence of D-U-D-U-D-U-D-U-D-U. Inspect load for shifting and record the results. Take two side (left and right) view photographs of PLS Truck Flatrack.

#### 4.6.1.9. Un-loading M2BB components of Combination A&B from their flatracks (Note: Care must be taken if load shifting occurs.)

- (1) Remove M2BB components from the flatrack.
- (2) Document all loose components and components that fall when removing tiedowns. Take photographs of fallen components, if any.
- (3) Inspect the flatrack for damage after the component removal. Record the results. Take photographs to show these damages, if any.

#### 4.6.2. Flatrack Load Combination D&C Test

##### 4.6.2.1. Loading M2BB components of Configuration D onto an empty M1077 flatrack

- (1) The M1077 flatrack is on the ground.
- (2) Load and tiedown M2BB transoms of Configuration D onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take three view photographs of this load (left side, right side, and end views).

##### 4.6.2.2. Loading M2BB components of Configuration C on an empty M1 flatrack

- (1) The M1 flatrack is on the ground.
- (2) Load and tiedown M2BB components of Configuration C onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take two side (left and right) view photographs of the load.

##### 4.6.2.3. Uploading and Downloading PLS Truck Flatrack (with components of Configuration D)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U.
- (2) Inspect load for shifting and record the results.

##### 4.6.2.4. Transloading PLS Truck Flatrack (with components of Configuration D)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T-F.
- (2) Inspect load for shifting and record the results.
- (3) Download the flatrack.

##### 4.6.2.5. Uploading and Downloading PLS Trailer Flatrack (with components of Configuration C)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U.
- (2) Inspect load for shifting and record the results.

##### 4.6.2.6. Transloading PLS Trailer Flatrack (with components of Configuration D)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. (The flatrack is now on the trailer.)
- (2) Inspect load for shifting and record the results.

##### 4.6.2.7. Road Test

###### 4.6.2.7.1. Road-marching

- (1) Upload PLS Truck Flatrack (with components of Configuration D) and connect to PLS Trailer Flatrack (with components of Configuration C).
- (2) Take two angled-side (left and right) view photographs.
- (3) Road-march 5 km on hard surface roads.
- (4) Stop, inspect load for shifting, and record the results.
- (5) Weigh the combination and record each weight as follows:
  - (a) the front tandem of the truck without the trailer,
  - (b) the rear tri-axle of the truck without the trailer, and
  - (c) the trailer.

- (6) Road-march 5 KM on un-improved roads.
- (7) Stop, inspect load for shifting, and record the results.

#### 4.6.2.7.2. Emergency braking test

Apply one hard stop on a hard surface road, inspect load for shifting, and record the results.

#### 4.6.2.7.3. Turning test

- (1) Conduct turning test for a turning radius of 36.5 m wall-to-wall.
- (2) Stop, inspect load for shifting, and record the results.

#### 4.6.2.8. Repeating downloading, uploading, and transloading

- (1) Unhook the trailer and download PLS Truck Flatrack (with components of Configuration C).
- (2) Transload PLS Trailer Flatrack (with components of Configuration D) from and to the trailer in the sequence of F-T-F-T-F-T-F-T-F. Inspect load for shifting and record the results. Download and upload PLS Trailer Flatrack in the sequence of D-U-D-U-D-U-D-U-D. Inspect load for shifting, and record the results. Take two side (left and right) view photographs and one end view photograph of PLS Trailer Flatrack.
- (3) Upload and download the flatrack with components of Configuration C in the sequence of U-D-U-D-U-D-U-D-U. Inspect load for shifting and record the results. Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. Inspect load for shifting and record the results. Take two side (left and right) view photographs of The load.

#### 4.6.2.9. Un-loading M2BB components of Combination D&C from their flatracks (Note: Care must be taken if load shifting occurs.)

- (1) Remove M2BB components from the flatrack.
- (2) Document all loose components and components that fall when removing tiedowns. Take photographs of fallen components, if any.
- (3) Inspect the flatrack for damage after the component removal. Record the results. Take photographs to show these damages, if any.

### 4.6.3. Flatrack Load Combination F&E Test

#### 4.6.3.1. Loading M2BB components of Configuration F onto an empty M1 flatrack

- (1) The M1 flatrack is on the ground.
- (2) Load and tiedown M2BB components of Configuration F onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take two side (left and right) view photographs of this load.

#### 4.6.3.2. Loading M2BB components of Configuration E on an empty M1 flatrack

- (1) The M1 flatrack is on the ground.
- (2) Load and tiedown M2BB components of Configuration E onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take two side (left and right) view photographs of this load.

4.6.3.3. Uploading and downloading PLS Truck Flatrack (with components of Configuration F)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U.
- (2) Inspect load for shifting and record the results.

4.6.3.4. Transloading PLS Truck Flatrack (with components of Configuration F)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T-F.
- (2) Inspect load for shifting and record the results.
- (3) Download the flatrack.

4.6.3.5. Uploading and downloading PLS Trailer Flatrack (with components of Configuration E)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U.
- (2) Inspect load for shifting and record the results.

4.6.5.6. Transloading PLS Trailer Flatrack (with components of Configuration E)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. (The flatrack is now on the trailer.)
- (2) Inspect load for shifting and record the results.

4.6.3.7. Road Test

4.6.3.7.1. Road-marching

- (1) Upload PLS Truck Flatrack (with components of Configuration F) and connect to PLS Trailer Flatrack (with components of Configuration E).
- (2) Take two angled-side (left and right) view photographs.
- (3) Road-march 5 km on hard surface roads.
- (4) Stop, inspect load for shifting, and record the results.
- (5) Weigh the combination and record each weight as follows:
  - (a) the front tandem of the truck without the trailer,
  - (b) the rear tri-axle of the truck without the trailer, and
  - (c) the trailer.
- (6) Road-march 5 KM on un-improved roads.
- (7) Stop, inspect load for shifting, and record the results.

4.6.3.7.2. Emergency braking test

Apply one hard stop on a hard surface road, inspect load for shifting, and record the results.

4.6.3.7.3. Turning test

- (1) Conduct turning test for a turning radius of 36.5 m wall-to-wall.
- (2) Stop, inspect load for shifting, and record the results.

4.6.3.8. Repeating downloading, uploading, and transloading

- (1) Unhook the trailer and download PLS Truck Flatrack (with components of Configuration F).
- (2) Transload PLS Trailer Flatrack (with components of Configuration E) from and to the trailer in the sequence of F-T-F-T-F-T-F-T-F. Inspect load for shifting and record the results. Download and upload PLS Trailer Flatrack in the sequence of D-U-D-U-D-U-D-U-D. Inspect load

for shifting, and record the results. Take two side (left and right) view photographs of PLS Trailer Flatrack.

- (3) Upload PLS Truck Flatrack (with components of Configuration F) and transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T. Inspect load for shifting and record the results. Download and upload PLS Truck Flatrack in the sequence of D-U-D-U-D-U-D-U-D. Inspect load for shifting and record the results. Take two side (left and right) view photographs of PLS Truck Flatrack.

4.6.3.9. Un-loading M2BB components of Configuration E from the flatrack (Note: Care must be taken if load shifting occurs.)

- (1) Remove M2BB components from the flatrack.
- (2) Document all loose components and components that fall when removing tiedowns. Take photographs of fallen components, if any.
- (3) Inspect the flatrack for damage after the component removal. Record the results. Take photographs to show these damages, if any.

#### 4.6.4. Flatrack Load Combination F&G Test

4.6.4.1. Loading M2BB components of Configuration G onto an empty M1 flatrack

- (1) The M1 flatrack is on the ground.
- (2) Load and tiedown M2BB components of Configuration G onto this flatrack.
- (3) Document if components do not fit as modeled.
- (4) Measure the highest load height and record it.
- (5) Document the tiedown procedures.
- (6) Take two side (left and right) view photographs of this load.

4.6.4.2. Uploading and downloading PLS Trailer Flatrack (with components of Configuration G)

- (1) Upload and download the flatrack in the sequence of U-D-U-D-U-D-U-D-U.
- (2) Inspect load for shifting and record the results.

4.6.4.3. Transloading PLS Trailer Flatrack (with components of Configuration G)

- (1) Transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. (The flatrack is now on the trailer.)
- (2) Inspect load for shifting and record the results.

4.6.4.4. Road Test

4.6.4.5.1. Road-marching

- (1) Upload PLS Truck Flatrack (with components of Configuration F) and connect to PLS Trailer Flatrack (with components of Configuration G).
- (2) Take two angled-side (left and right) view photographs.
- (3) Road-march 5 km on hard surface roads.
- (4) Stop, inspect load for shifting, and record the results.
- (5) Weigh the combination and record each weight as follows:
  - (a) the front tandem of the truck without the trailer,
  - (b) the rear tri-axle of the truck without the trailer, and
  - (c) the trailer.
- (6) Road-march 5 KM on un-improved roads.
- (7) Stop, inspect load for shifting, and record the results.

4.6.4.5.2. Emergency braking test

Apply one hard stop on a hard surface road, inspect load for shifting, and record the results.

4.6.4.5.3. Turning test

- (1) Conduct turning test for a turning radius of 36.5 m wall-to-wall.
- (2) Stop, inspect load for shifting, and record the results.

4.6.4.6. Repeating downloading, uploading, and transloading

- (1) Unhook the trailer and download PLS Truck Flatrack (with components of Configuration F).
- (2) Transload PLS Trailer Flatrack (with components of Configuration G) from and to the trailer in the sequence of F-T-F-T-F-T-F-T-F. Inspect load for shifting and record the results. Download and upload PLS Trailer Flatrack in the sequence of D-U-D-U-D-U-D-U-D. Inspect load for shifting, and record the results. Take two side (left and right) view photographs of PLS Trailer Flatrack.
- (3) Upload PLS Truck Flatrack (with components of Configuration F) and transload the flatrack to and from the trailer in the sequence of T-F-T-F-T-F-T-F-T. Inspect load for shifting and record the results. Download and upload PLS Truck Flatrack in the sequence of D-U-D-U-D-U-D-U-D. Inspect load for shifting and record the results. Take two side (left and right) view photographs of PLS Truck Flatrack.

4.6.4.7. Un-loading M2BB components of Combination F&G from their flatracks  
(Note: Care must be taken if load shifting occurs.)

- (1) Remove M2BB components from the flatrack.
- (2) Document all loose components and components that fall when removing tiedowns. Take photographs of fallen components, if any.
- (3) Inspect the flatrack for damage after the component removal. Record the results. Take photographs to show these damages, if any.

## **5. REQUIRED MATERIEL RESOURCES**

### **5.1. Test location**

US Engineer School at Fort Leonard Wood, MO 65473-6620. The Road Test map is illustrated in Attachment 4.

### **5.2. Materials**

(a) M2BB Components: Components of the M2BB Basic set and M2BB Erection Equipment set listed in Attachment 3, Required Material Resources.

(b) Test Equipment: One PLS transporter M1075, one PLS trailer M1076, four PLS ISO flatracks M1, and one PLS flatrack M1077.

(c) Material Handling Equipment: Two 10-K Rough Terrain Forklift trucks.

(d) One High Mobility Multi-Wheeled Vehicle (HMMWV).

Attachment 3 lists all required material resources for the test.

### **5.3. Personnel**

(a) One engineer (TARDEC/Support Bridge Team) to monitor the test.

(b) Two QA personnel (US Army Sierra Depot) who have knowledge in M2BB to help the engineer in monitoring the test and recording data.

(c) Two soldiers with MOS 88M to operate the PLS Transporter M1075 with PLS Trailer M1076 and M1/M1077 Flatracks.

(d) A loading/unloading party includes two NCOs and twelve EM (MOS 12C).

(e) One driver to operate the HMMWV.

## 6. COORDINATION LIST

- (1) US Army Research, Development and Engineering Center (AMSTA-TR-R/Support Bridge Team/Mr. Anh Nguyen, DSN 786-6291)
- (2) US Army Aviation-Troop Command (AMSAT-D-WME/Materiel Manager Bridging/Ms. Pamela Kniess, DSN 490-2042)
- (3) US Army Engineer School (ATSE-TSM/Engineer Combat Systems/CPT Guilford, DSN 676-6096)
- (4) Military Traffic Management Command (MTMC Transportation Engineering Agency/MTTE-DPE/Mr. John Newman, DSN 927-4646)
- (5) Sierra Army Depot (SIOSI-QA/Mr. Eddie Sanchez, DSN 855-4449)
- (6) PM-HTV/SFAE-TWV-HTV/LTC John Macik, DSN 786-5220)
- (7) TACOM Safety Office (AMSTA-CS-CZ/Mr. George Jarvis, DSN 786-5636)
- (8) TACOM Quality Team (AMSTA-TR-E/HTV/312/Mr. Michael Marceau, DSN 786-8311)
- (9) TACOM Quality & Test Team (AMSTA-TR-E/TDS/314/Mr. Henry L. Martin, DSN 786-6963)



## **7. TEST SCHEDULE**

(a) The test is scheduled for two weeks for both M-2 Bailey Bridge and Medium Girder Bridge Palletization from 7 to 18 April 1997. The first six days is for the M2BB Palletization test. USAES will attempt to schedule the soldiers for one additional week.

(b) Detailed test schedule is illustrated in Attachment 5.

## 8. ATTACHMENTS

- (1) Attachment 1: M-2 Bailey Bridge Palletization Flatrack  
Load Configuration Using M1/M1077 Flatracks
- (2) Attachment 2: Computer Models of M2BB Palletization Flatrack Loads
- (3) Attachment 3: Required Material Resources
- (4) Attachment 4: Road Test Map
- (5) Attachment 5: M2BB Palletization Test Schedule
- (6) Attachment 6: Data Collection Sheets

# ATTACHMENT 1

## M-2 BAILEY BRIDGE PALLETIZATION FLATRACK LOAD CONFIGURATION USING M1/M1077 FLATRACKS

LOAD : CONF :	TYPE & NUMBER OF COMPONENTS	NET WEIGHT kg (lb)	HEIGHT <sup>a</sup> m (in)	EST CG <sub>Z</sub> <sup>a</sup> m (in)	NO. OF LOADS REQUIRED 80' DS : 130' DD
A :	32 Rakers 162 Soft Lumber, Dimension <sup>b</sup> Erection Equipment Boxes <sup>b,c</sup>	6816 (15026)	1.58 (62.3)	0.62 (24.5)	1 : 2
B :	9 Panels 97 Soft Lumber, Timber <sup>b</sup> Miscellaneous Boxes <sup>d</sup>	6863 (15131)	1.84 (72.3)	1.02 (40.3)	1 : 2
C :	9 Panels 12 Plain Stringers 8 Sway Braces	4018 ( 8857)	1.84 (72.3)	1.04 (40.8)	3 : 6
D :	28 Transoms (M1077)	7865 (17304)	0.77 (30.5)	0.51 (20.2)	1 : 2
E :	9 Panels 8 Button Ramps 25 Bracing Frames 8 Ramp Pedestals 4 Base Plates 6F and 6M End Posts 40 Footwalk (FW) Bearers 40 FW Posts 8 Shoes Bearings	6675 (14715)	1.84 (72.3)	1.04 (41.0)	1 : 2
F :	9 Panels 12 Ribands	4464 ( 9841)	1.84 (72.3)	1.03 (40.5)	2 : 4
G :	185 Chess 18 Footwalks	6304 (13897)	2.06 (81.3)	1.74 (68.5)	1 : 2

<sup>a</sup> From the base of the flatrack

<sup>b</sup> Erection Equipment, only loaded if required

<sup>c</sup> Erection Equipment Boxes include 7 Carrying Bars, 4 Double Blocks, 2 Triple Blocks, 2 Snatch Blocks, 2 Pin Extractors, 6 Double-Face Hammers, 1 Carpenter Hammer, 5 Socket Wrench Handles, 6 Holdfast w/ 9 pickets, 3 Chord Jacks, 5 15-ton Rack Bar Jacks, 3 Panel Levers, 12 Launching Nose Links, 3 Steel Nail, 50lb/Box, 10 Common-Nail Box, 6 Plain Rollers, 6 Rocking Rollers, 3 Guide Roller Assemblies, 2 Transom Rollers, 1 3" Circular Rope, 1 2 1/4" Circular Rope, 2 2" Circular Ropes, 2 Anchor-Type Shackles, 4 Jack Shoes, 2 Sling & Wire Rope Assemblies, 5 1 1/8", 12 pt Sockets, 5 1 7/8", 12 pt Sockets, 9 Steel Anchor Stakes, 6 Rocking Roller Templates, 6 Plain Roller Templates, 10 Carrying Tongs, 16 Wood Wedges, 2 Wire Rope Assemblies, 2 3/4", 12 pt Box Wrenches, 5 1 1/8" Open End Wrenches, 5 1 1/2" Open End Wrenches, 10 1 1/8" Single Socket Wrenches.

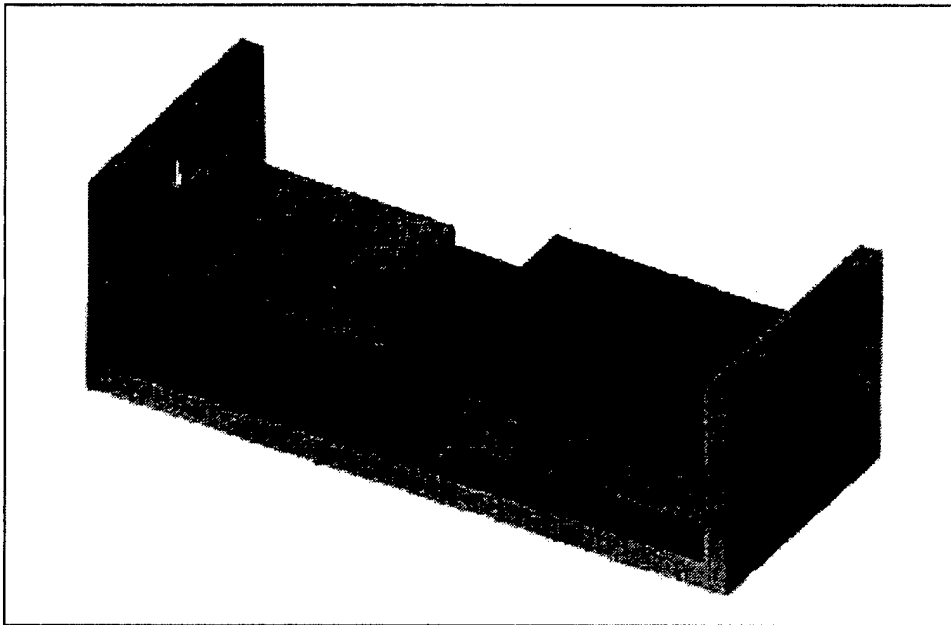
<sup>d</sup> Miscellaneous Boxes include 250 Bracing Bolts, 100 Chords Bolts, 150 Ribald Bolts, 150 Transom Clamps, 20 Steel Pickets, 150 Panel Pins, 15 Short Panel Pins, 25 Sway Braces Pins, 13 Tie Plates, 500 Pin Retainers, 1 Roll of Ropes, and 10 Tools and Parts Bags, 12 Hex Nuts with Caps, and 12 End Post Bolts.

**ATTACHMENT 2**

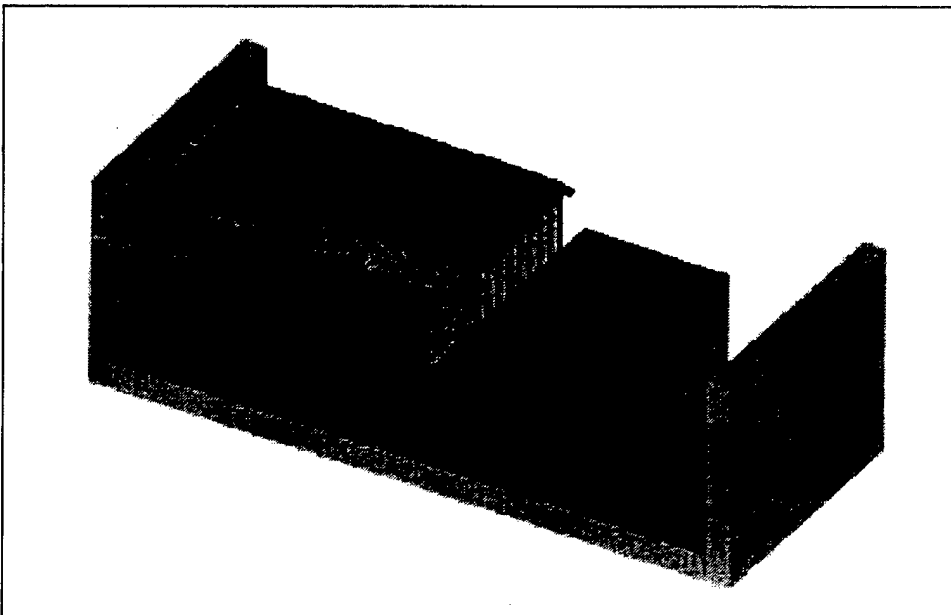
**COMPUTER MODELS  
OF  
M2BB PALLETIZATION FLATRACK LOADS**

1. Figure 1: Flatrack Load Configuration A (M1)
2. Figure 2: Flatrack Load Configuration B (M1)
3. Figure 3: Flatrack Load Configuration C (M1)
4. Figure 4: Flatrack Load Configuration D (M1077)
5. Figure 5: Flatrack Load Configuration E (M1)
6. Figure 6: Flatrack Load Configuration F (M1)
7. Figure 7: Flatrack Load Configuration G (M1)

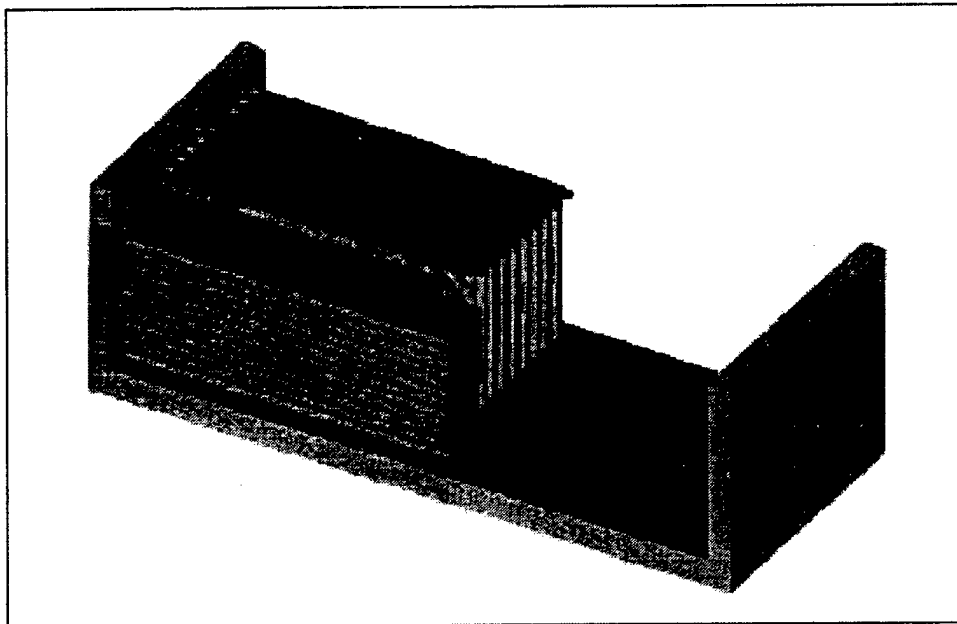
**Figure 1: FLATRACK LOAD CONFIGURATION A (M1)**  
(32 Rakers, 18 Button Stringers, 162 Soft Lumber -  
Dimension, Erection Equipment Boxes)



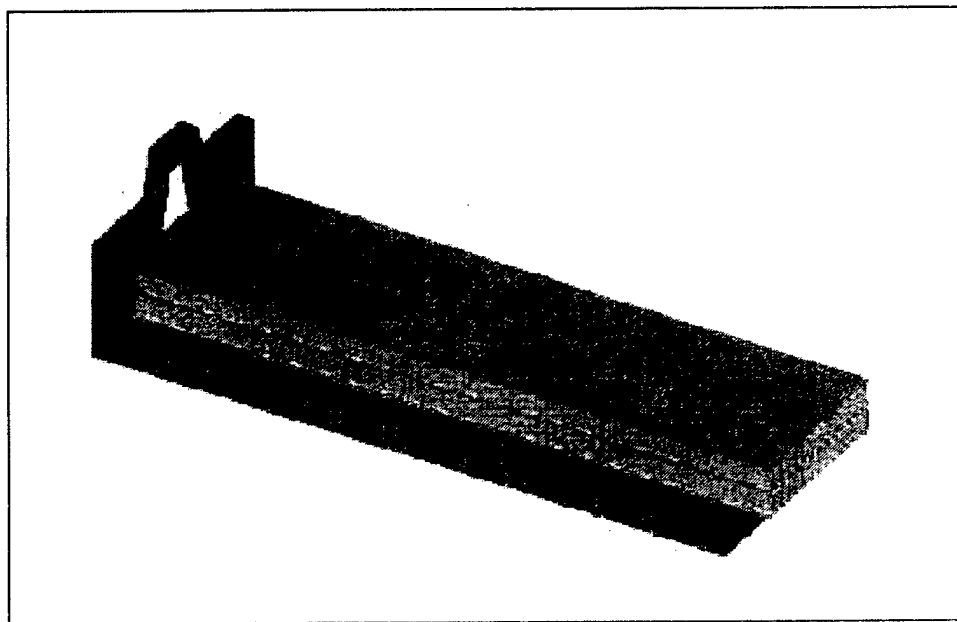
**Figure 2: FLATRACK LOAD CONFIGURATION B (M1)**  
(9 Panels, 8 Sway Braces, 97 Soft Lumber - Timber,  
Miscellaneous Boxes)



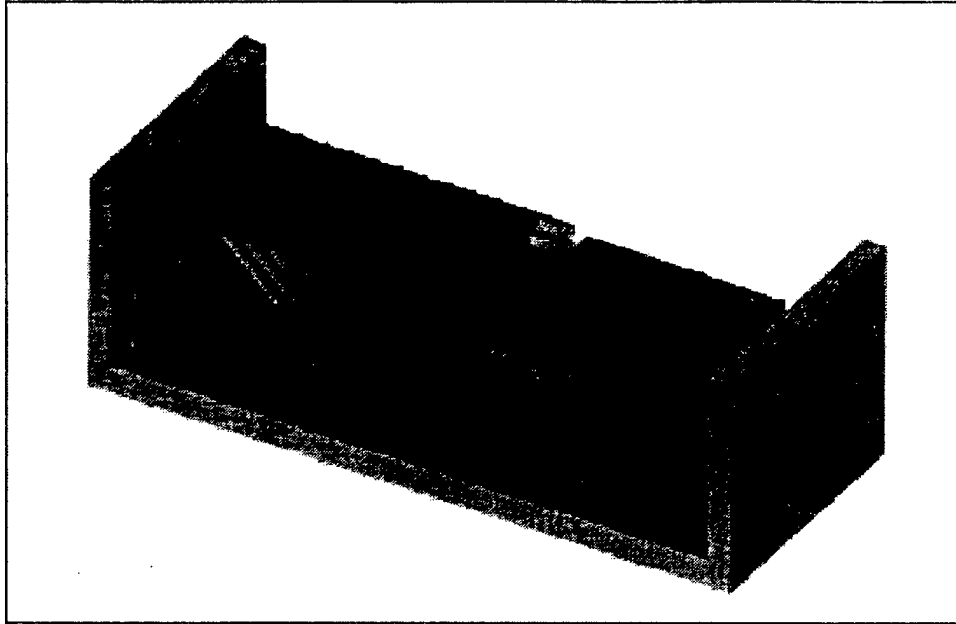
**Figure 3: FLATRACK LOAD CONFIGURATION C (M1)**  
(9 Panels, 12 Plain Stringers, 8 Sway Braces)



**Figure 4: FLATRACK LOAD CONFIGURATION D (M1077)**  
(28 Transoms)



**Figure 5: FLATRACK LOAD CONFIGURATION E (M1)**  
(9 Panels, 25 Bracing Frames, 8 Button Ramps, 8 Ramp Pedestals, 4 Base Plates, 6 Female End Posts, 6 Male End Posts, 40 Footwalk Bearer, 40 Footwalk Posts, 8 Bearing Shoes)



**Figure 6: FLATRACK LOAD CONFIGURATION F (M1)**  
(9 Panels, 8 Plain Ramps, 12 Ribbands)

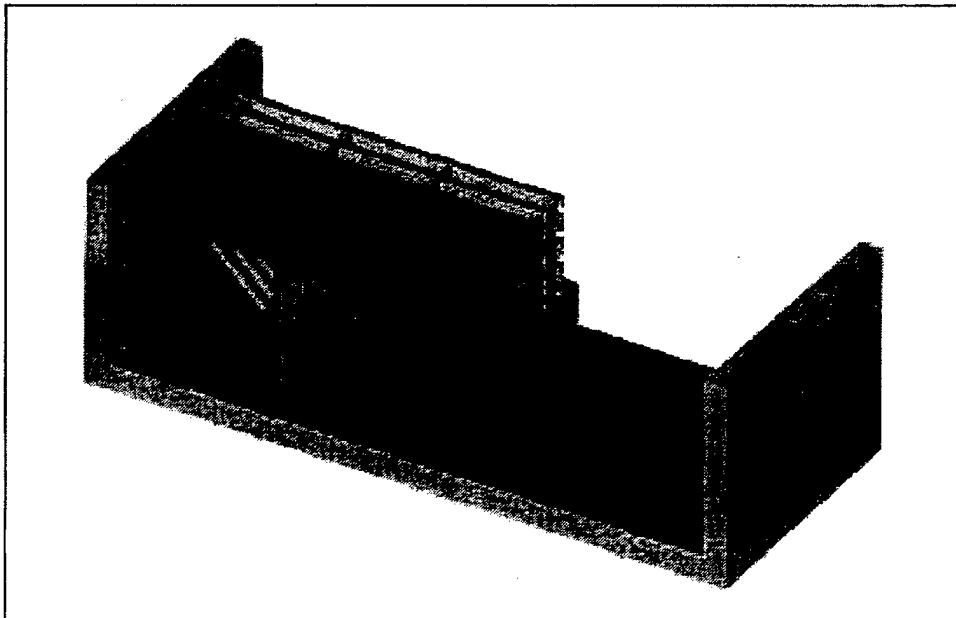
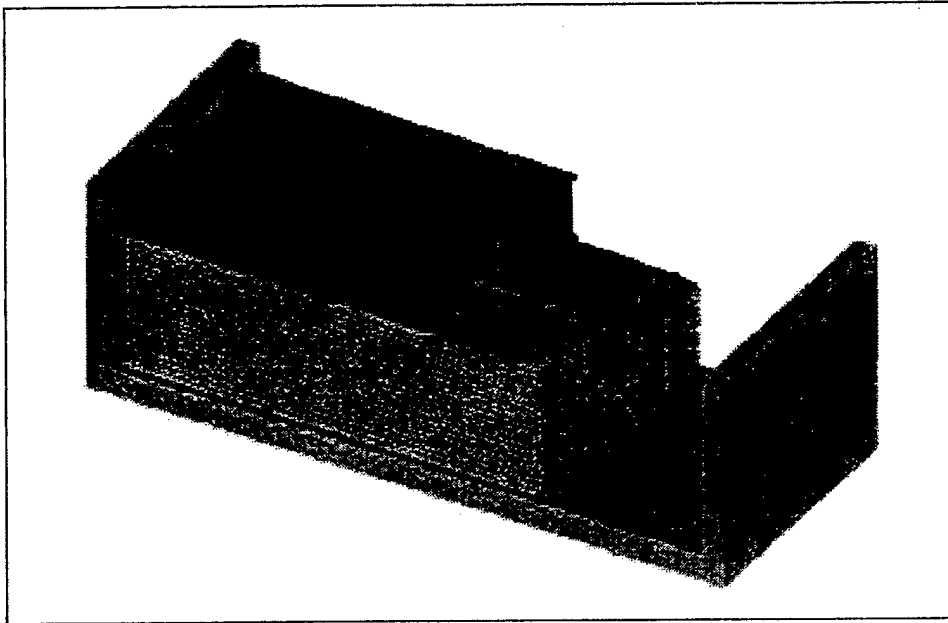


Figure 7: FLATRACK LOAD CONFIGURATION G (M1)  
(185 Chess, 18 Footwalks)





# ATTACHMENT 3

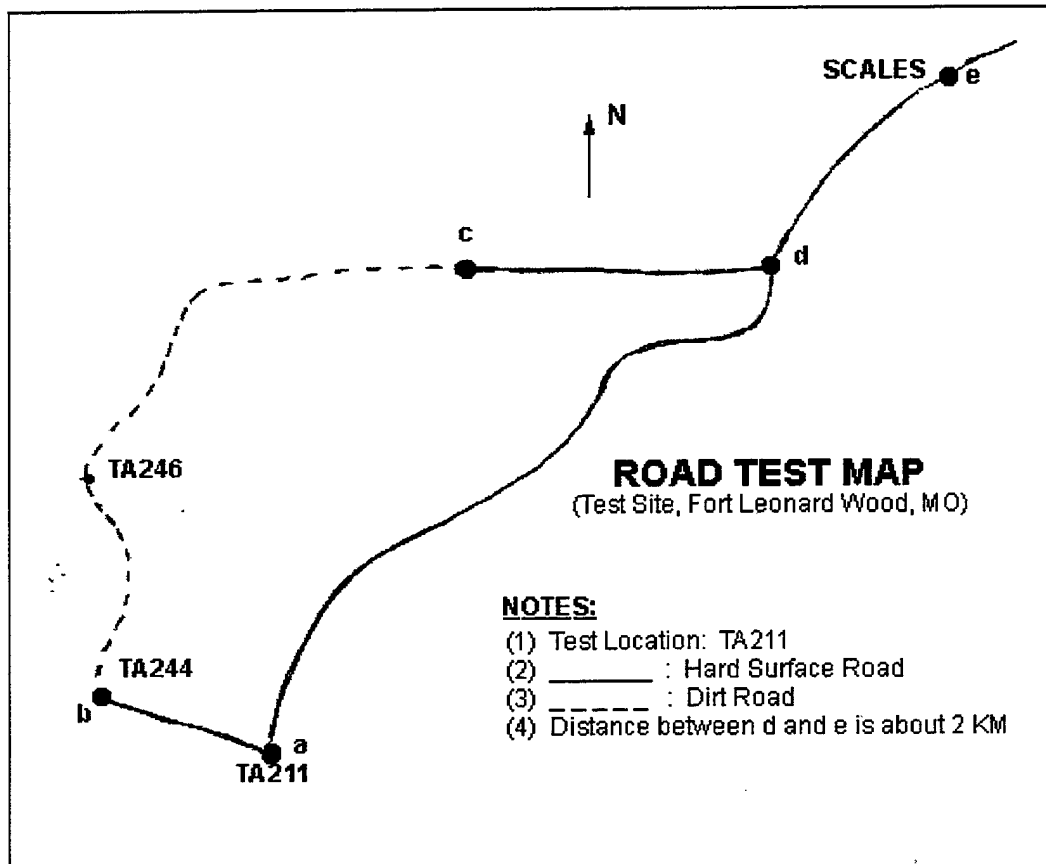
## REQUIRED MATERIAL RESOURCES

ITEM DESCRIPTION	:#RQD :	NSN	:	NOTES
<b>M-2 Bailey Bridge Basic Components</b>				
Transom	: 28	:5420-00-371-9916	:	
Panel	: 27	:5420-00-355-6754	:	
Plain Stringer	: 24	:5420-00-355-7031	:	
Button Stringer	: 18	:5420-00-355-7028	:	
Plain Ramp	: 8	:5420-00-355-6947	:	
Button Ramp	: 8	:5420-00-355-6946	:	
Riband, Guardrail	: 12	:5420-00-355-6949	:	
Chess	: 185	:5420-00-377-0759	:	
Footwalk, Aluminum	: 18	:5420-00-999-6597	:	
Footwalk, Wood	: 18	:5420-00-371-9881	:	
Footwalk Bearer	: 40	:5420-00-355-6479	:	
Footwalk Post	: 40	:5420-00-355-6937	:	
Female End Post	: 6	:5420-00-355-6928	:	
Male End Post	: 6	:5420-00-355-6929	:	
Raker	: 32	:5420-00-355-6942	:	
Sway Brace	: 16	:5420-00-377-0755	:	
Bracing Frame	: 25	:5420-00-355-6661	:	
Ramp Pedestal	: 8	:5420-00-371-9895	:	
Base Plate	: 4	:5420-00-355-6797	:	
Shoe Bearing	: 8	:3040-00-355-6483	:	
<b>Miscellaneous Items</b>	:	:	:	
Bracing Bolt	: 250	:5306-00-355-6492	:	
Chord Bolt	: 100	:5306-00-355-6493	:	
Riband Bolt	: 150	:5306-00-395-2094	:	
Transom Clamp	: 150	:5420-00-355-6596	:	
Steel Picket	: 20	:5420-00-371-9897	:	
Panel Pin	: 150	:5420-00-377-0771	:	
Short Panel Pin	: 15	:5420-00-377-0770	:	
Sway Brace Pin	: 25	:5420-00-355-6781	:	
Tie Plate	: 13	:5420-00-355-6912	:	
Pin Retainer	: 500	:5420-00-061-2873	:	
Roll of Ropes	: 1	:4020-00-290-5810	:	
Parts and Tools Bag	: 10	:5420-00-267-0058	:	
Hex Nut with Cap	: 12	:5310-00-763-8921	:	
End Post Bolt	: 12	:5305-00-947-4360	:	
	:	:	:	

ITEM DESCRIPTION	:#RQD :	NSN	: NOTES
<b>M-2 Bailey Bridge Erection Equipment</b>			
Soft Lumber, Dimension	: 162	:5510-00-255-9483	:
Soft Lumber, Timber	: 97	:5510-00-255-9482	:
Others	:	:	:
Carrying Bar	: 7	:5420-00-355-6459	:
Double Block for ¾" rope	: 4	:3940-00-984-0225	:
Triple Block for 1" rope	: 2	:3940-00-926-3727	:
Snatch Block for ¾" rope	: 2	:3940-00-072-0351	:
Pin Extractor	: 2	:5420-00-355-6656	:
Hand Double-Face Hammer	: 6	:5120-00-900-6096	:
Hand Carpenter Hammer	: 1	:5120-00-892-5485	:
Socket Wrench Handle	: 5	:5120-00-249-1076	:
Holdfast Assembly	: 6	:5420-00-371-9890	:
Chord Jack w/ Handle	: 3	:5420-00-355-6727	:
15-ton Rack Bar Jack	: 5	:5120-00-224-7516	:
Panel Lever	: 3	:5420-00-355-6738	:
Launching Nose Link	: 12	:5420-00-355-6747	:
Rubber Mallet	: 5	:5120-00-293-3399	:
Steel Nail, 50lb/Box	: 3	:5315-00-010-4666	:
Common-Nail Box	: 10	:5315-00-162-3126	:
Plain Roller	: 6	:5420-00-355-6958	:
Rocking Roller	: 6	:5420-00-355-6960	:
Guide Roller Assembly	: 3	:5420-00-572-1235	:
Transom Roller	: 2	:5420-00-393-0372	:
3" Circular Rope	: 1	:4020-00-231-9014	:
2¾" Circular Rope	: 1	:4020-00-238-7734	:
2" Circular Rope	: 2	:4020-00-290-5810	:
Anchor-Type Shackle	: 2	:4030-00-290-1388	:
Jack Shoe	: 4	:3040-00-355-6989	:
Sling & Wire Rope Assembly	: 2	:3940-00-214-7493	:
12PT, 1 " Opening Socket	: 5	:5120-00-261-2815	:
12PT, 1 " Opening Socket	: 5	:5120-00-261-2827	:
Steel Anchor Stake	: 9	:5420-00-371-9897	:
Rocking Roller Template	: 6	:5420-00-355-7061	:
Plain Roller Template	: 6	:5420-00-355-7060	:
Carrying Tong	: 10	:5420-00-355-7065	:
Wood Wedge	: 16	:5510-00-240-5793	:
Wire Rope Assembly	: 2	:4010-00-270-5497	:
¾", 12 PT Box Wrench	: 2	:5120-00-449-8097	:
1 " Open End Wrench	: 5	:5120-00-277-1194	:
1½" Open End Wrench	: 5	:5120-00-277-1196	:
1 " Open End Wrench	: 5	:5129-00-277-1200	:
1 " Single Socket Wrench	: 10	:5120-00-224-2536	:
	:	:	:
<b>Other Material &amp; Equipment</b>			
M1075 PLS Transporter	: 1	:2320-01-304-2278	:
M1 PLS ISO Flatrack	: 4	:3990-01-406-1340	:
M1077 PLS Flatrack	: 1	:3990-01-307-7676	:
M1076 PLS Trailer	: 1	:2320-01-303-5197	:
HMMWV	: 1	:	:
Web Strap (10,000-lb rated)	: 110	:5340-01-204-3009	:
10K Rough Terrain Forklift	: 2	:3930-01-054-3833	:
	:	:	:
	:	:	:

ATTACHMENT 4

ROAD TEST MAP



# ATTACHMENT 5

## M2BB PALLETIZATION TEST SCHEDULE

EVENT	EVERYONE	TRUCK	CREW1	CREW2	
					DAY 1
BRIEF PERSONNEL	3.0				
INSPECT/WEIGHT TEST EQUIP		2.5			
INSPECT BRIDGE		3.0			
LOAD FLATRACKS A&B			4.0	4.0	
					DAY 2
UPLOAD/DOWNLOAD/TRANSLOAD A&B		2.5			
ROAD TEST A&B		4.0			
SECOND UPLOAD/DOWNLOAD/TRANSLOAD		2.0			
LOAD FLATRACKS D&C			4.0	4.0	
UNLOAD A&B			2.0	2.0	
					DAY 3
UPLOAD/DOWNLOAD/TRANSLOAD D&C		2.5			
ROAD TEST D&C		4.0			
SECOND UPLOAD/DOWNLOAD/TRANSLOAD		2.0			
LOAD FLATRACKS F&E			4.0	4.0	
LOAD FLATRACK G			2.0		
UNLOAD D&C			2.0	2.0	
					DAY 4
UPLOAD/DOWNLOAD/TRANSLOAD F&E		2.5			
ROAD TEST F&E		4.0			
SECOND UPLOAD/DOWNLOAD/TRANSLOAD		2.0			
					DAY 5
UPLOAD/DOWNLOAD/TRANSLOAD F&G		1.5			
ROAD TEST F&G		3.0			
SECOND UPLOAD/DOWNLOAD/TRANSLOAD		1.5			
UNLOAD FLATRACK E				2.0	
					DAY 6
UNLOAD FLATRACKS F&G			2.0	2.0	
COMMENT & DISCUSSION	3.0				

**ATTACHMENT 6**

**DATA COLLECTION SHEETS**

1. Data Collection Sheets for Flatrack Load Combination A&B
2. Data Collection Sheets for Flatrack Load Combination D&C
3. Data Collection Sheets for Flatrack Load Combination F&E
4. Data Collection Sheets for Flatrack Load Combination F&G

# DATA COLLECTION SHEET

(Note: If more space is needed, use the back of this sheet.)

FLATRACK LOAD COMBINATION A&B (BEFORE ROAD TEST)

## 1. CONFIGURATION A - LOAD/TIEDOWN

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Do M2BB components fit as modeled? ☐ YES ☐ NO  
(b) Highest Load Height from the flatrack base: \_\_\_\_\_ m  
(c) Description of Tiedown Procedures:

	R→	1	2	3	4	5	6	7	8	9	10	11
F												
r												
o												
n												
t												
U												
P												
r												
i												
g												
h												
t												
L→		1	2	3	4	5	6	7	8	9	10	11

- (d) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_
- (e) Comments: \_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION A&B (BEFORE ROAD TEST)

#### 2. CONFIGURATION B - LOAD/TIEDOWN

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Do M2BB components fit as modeled? ☐ YES ☐ NO  
(b) Highest Load Height from the flatrack base: \_\_\_\_\_ m  
(c) Description of Tiedown Procedures:

	R→	1	2	3	4	5	6	7	8	9	10	11	
F r o n t  U p r i g h t	1. NOTATION:												
	1R: first tiedown ring on the right												
	10L: tenth tiedown ring on the left												
	RE: ratchet end of the strap												
	FE: free end of the strap												
	2. Identify where each strap goes from and terminates starting from the front to rear:												
	Example: Strap 1: 1RRE → 1LFE												
	This means the first strap's ratchet end is connected to the first right side tiedown ring and the free end is connected to the first left side tiedown ring.												
	L→	1	2	3	4	5	6	7	8	9	10	11	

- (d) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_
- (e) Comments: \_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION A&B (BEFORE ROAD TEST)

#### 3. CONFIGURATION A - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 4. CONFIGURATION B - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION A&B (ROAD TEST)

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

#### 1. ROAD-MARCHING

- (a) Photographs taken? ☐ left angled-side view  
☐ right angled-side view
- (b) Weight      Truck Front Tandem (w/o trailer): \_\_\_\_\_ kg  
                  Truck Rear Tri-axle (w/o trailer): \_\_\_\_\_ kg  
                  Trailer with M2BB Components : \_\_\_\_\_ kg
- (c) Does the load shift when road test on hard surface roads? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (d) Does the load shift when road test on un-improved roads? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 2. EMERGENCY BRAKING TEST

- (a) Does the load shift when emergency braking? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 3. TURNING TEST

- (a) Does the load shift when the truck turning? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION A&B (AFTER ROAD TEST)

#### 1. CONFIGURATION B - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 2. CONFIGURATION A - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 3. UNLOADING CONFIGURATION B

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 4. UNLOADING CONFIGURATION A

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# DATA COLLECTION SHEET

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION D&C (BEFORE ROAD TEST)

## 1. CONFIGURATION D - LOAD/TIEDOWN

Date: Start Time: End Time:

- (a) Do M2BB components fit as modeled? ☐ YES ☐ NO  
 (b) Highest Load Height from the flatrack base: \_\_\_\_\_ m  
 (c) Description of Tiedown Procedures:

$$\mathbf{R} \rightarrow \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \end{matrix}$$

A  
-  
F  
r  
a  
m  
e

1. NOTATION:

1R: first tiedown ring on the right  
10L: tenth tiedown ring on the left  
RE: ratchet end of the strap  
FE: free end of the strap

2. Identify where each strap goes from and terminates starting from the front to rear:

Example: Strap 1: 1RRE → 1LFE

This means the first strap's ratchet end is connected to the first right side tiedown ring and the free end is connected to the first left side tiedown ring.

$L \rightarrow$  1      2      3      4      5      6      7      8      9      10      11

(d) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

(e) Comments:

(Note: If more space is needed, use the back of this sheet.)

## 2. CONFIGURATION C - LOAD/TIEDOWN

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- $$\mathbf{R} \rightarrow \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \end{matrix}$$

F  
r  
o  
n  
t

1. NOTATION:

1R: first tiedown ring on the right  
10L: tenth tiedown ring on the left  
RE: ratchet end of the strap  
FE: free end of the strap

U  
P  
r  
i  
g  
h  
t

2. Identify where each strap goes from and terminates starting from the front to rear:

Example: Strap 1: 1RRE → 1LFE

This means the first strap's ratchet end is connected to the first right side tiedown ring and the free end is connected to the first left side tiedown ring.

**L**→ 1      2      3      4      5      6      7      8      9      10      11

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

- (e) Comments: \_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION C&D (BEFORE ROAD TEST)

#### 3. CONFIGURATION D - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 4. CONFIGURATION C - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION D&C (ROAD TEST)

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

## 1. ROAD-MARCHING

- (a) Photographs taken?      left angled-side view  
   right angled-side view
- (b) Weight      Truck Front Tandem (w/o trailer): \_\_\_\_\_ kg  
                      Truck Rear Tri-axle (w/o trailer): \_\_\_\_\_ kg  
                      Trailer with M2BB Components : \_\_\_\_\_ kg
- (c) Does the load shift when road test on hard surface roads?  
Explain if YES:
- ☐ YES      ☐ NO

- (d) Does the load shift when road test on un-improved roads?  
☐ YES ☐ NO

## 2. EMERGENCY BRAKING TEST

- (a) Does the load shift when emergency braking? ☐ YES ☐ NO  
Explain if YES:

### 3. TURNING TEST

- (a) Does the load shift when the truck turning? ☐ YES ☐ NO  
Explain if YES:

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION D&C (AFTER ROAD TEST)

#### 1. CONFIGURATION D - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 2. CONFIGURATION C - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 3. UNLOADING CONFIGURATION D

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 4. UNLOADING CONFIGURATION C

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# DATA COLLECTION SHEET

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&E (BEFORE ROAD TEST)

## 1. CONFIGURATION F - LOAD/TIEDOWN

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Do M2BB components fit as modeled? ☐ YES ☐ NO  
 (b) Highest Load Height from the flatrack base: \_\_\_\_\_ m  
 (c) Description of Tiedown Procedures:

	R→	1	2	3	4	5	6	7	8	9	10	11
F												
r	1. NOTATION:											
o												
n												
t												
U	2. Identify where each strap goes from and terminates starting											
P	from the front to rear:											
r	<u>Example:</u> Strap 1: 1RRE → 1LFE											
i	This means the first strap's ratchet end is connected to											
g	the first right side tiedown ring and the free end is connected to											
h	the first left side tiedown ring.											
t												
L→		1	2	3	4	5	6	7	8	9	10	11

- (d) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_
- (e) Comments: \_\_\_\_\_



## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&E (BEFORE ROAD TEST)

#### 2. CONFIGURATION E - LOAD/TIEDOWN

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Do M2BB components fit as modeled? ☐ YES ☐ NO  
(b) Highest Load Height from the flatrack base: \_\_\_\_\_ m  
(c) Description of Tiedown Procedures:

	R→	1	2	3	4	5	6	7	8	9	10	11
F r o n t	1. NOTATION:											
U p p e r	2. Identify where each strap goes from and terminates starting from the front to rear:											
	Example: Strap 1: 1RRE → 1LFE											
	This means the first strap's ratchet end is connected to the first right side tiedown ring and the free end is connected to the first left side tiedown ring.											
h i g h t												
	L→	1	2	3	4	5	6	7	8	9	10	11

- (d) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_
- (e) Comments: \_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&E (BEFORE ROAD TEST)

#### 3. CONFIGURATION F - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 4. CONFIGURATION E - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&E (ROAD TEST)

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

#### 1. ROAD-MARCHING

- (a) Photographs taken? 9 left angled-side view  
9 right angled-side view
- (b) Weight      Truck Front Tandem (w/o trailer): \_\_\_\_\_ kg  
                  Truck Rear Tri-axle (w/o trailer): \_\_\_\_\_ kg  
                  Trailer with M2BB Components : \_\_\_\_\_ kg
- (c) Does the load shift when road test on hard surface roads? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

- (d) Does the load shift when road test on un-improved roads? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

#### 2. EMERGENCY BRAKING TEST

- (a) Does the load shift when emergency braking? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

#### 3. TURNING TEST

- (a) Does the load shift when the truck turning? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&E (AFTER ROAD TEST)

#### 1. CONFIGURATION E - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 2. CONFIGURATION F - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 3. UNLOADING CONFIGURATION E

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# DATA COLLECTION SHEET

(Note: If more space is needed, use the back of this sheet.)

## FLATRACK LOAD COMBINATION F&G (BEFORE ROAD TEST)

### 1. CONFIGURATION G - LOAD/TIEDOWN

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Do M2BB components fit as modeled? ☐ YES ☐ NO  
(b) Highest Load Height from the flatrack base: \_\_\_\_\_ m  
(c) Description of Tiedown Procedures:

	R→	1	2	3	4	5	6	7	8	9	10	11	
F r o n t  U p r i g h t	1. NOTATION:  1R: first tiedown ring on the right 10L: tenth tiedown ring on the left RE: ratchet end of the strap FE: free end of the strap  2. Identify where each strap goes from and terminates starting from the front to rear: <u>Example:</u> Strap 1: 1RRE → 1LFE This means the first strap's ratchet end is connected to the first right side tiedown ring and the free end is connected to the first left side tiedown ring.												

L→ 1 2 3 4 5 6 7 8 9 10 11

- (d) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_  
(e) Comments: \_\_\_\_\_

## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&G (BEFORE ROAD TEST)

#### 3. CONFIGURATION G - UPLOADING/DOWNLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(Note: If more space is needed, use the back of this sheet.)

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

(a) Photographs taken?      left angled-side view  
  right angled-side view

(b) Weight      Truck Front Tandem (w/o trailer): \_\_\_\_\_ kg  
                       Truck Rear Tri-axle (w/o trailer): \_\_\_\_\_ kg  
                       Trailer with M2BB Components : \_\_\_\_\_ kg

(c) Does the load shift when road test on hard surface roads? ☐ YES ☐ NO

Explain if YES: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(d) Does the load shift when road test on un-improved roads?  
☐ YES ☐ NO

Explain if YES: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(a) Does the load shift when emergency braking? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

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(a) Does the load shift when the truck turning? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_

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## DATA COLLECTION SHEET (CONT'D)

(Note: If more space is needed, use the back of this sheet.)

### FLATRACK LOAD COMBINATION F&G (AFTER ROAD TEST)

#### 1. CONFIGURATION G - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 2. CONFIGURATION F - REPEATING DOWNLOADING/UPLOADING/TRANSLOADING

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

- (a) Does the load shift when transloaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Does the load shift when up/down-loaded? ☐ YES ☐ NO  
Explain if YES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Photographs taken? ☐ left side view ☐ right side view  
☐ end view ☐ \_\_\_\_\_

#### 3. UNLOADING CONFIGURATION G

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### 4. UNLOADING CONFIGURATION F

Date: \_\_\_\_\_ Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_